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The Illinois Coal Measure Fossils and their Use in Determining Coal Horizons.

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A Discussion of the Authenticity of Professor A.H.Worthen's Classification of the Coal Seams, and the Value of Fossils as a Means of Identifying Coal Horizons in this State.

1896.

Introduction.

My attention was first drawn to the fossils of the Illinois Coal Measures by reading Professor Worthen's attempt to arrange them in natural groups characteristic of coal and limestone horizons. There seemed to be too much uncertainty in the scheme to make it a success, for, having found a group of fossils quite persistent along a horizon, we are suddenly surprised to find nearly the same group appearing higher in the series, and also in lower strata.

Out of these doubts grew the desire to investigate the claims of the problem and to attempt its solution. Accordingly, the collections at the University and in the State Museum at Springfield were examined; and by correspondence much material was obtained from private collectors in the state. The library furnished all the literature which was within the reach of Professor Worthen, and considerable to which he did not have access. Of course the collections have been enlarged since he used them.

Further study may make modifications, but I am convinced that the present knowledge of the subject will bear me out in my conclusions, although they do not harmonize with Professor Worthen's results.

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Bibliography.

Geological Survey of Illinois.
" " " Indiana.
" " " Iowa.
" " " Kentucky.
" " " Missouri.
" " " Pennsylvania.
U.S.Geol. Sur. Vol.10.(Shaler).
U.S.Geol. Sur. Bull.No.39,31,33.
Amer. Geol. Vol.14.
Geol.Soc. of Amer.Vol.5.(Keyes).
N.Y.State Museum Reports.
Proc.Acad.Nat.Scien. of Phil. 1353.
Penn. Coal Flora.
Dictionary of Fossils.
Bureau of Labor Statistics.
Miller's North American Palaeontology.
Lydekker and Nickolson, Palae.
Zittel's Palae.
Britannica, Barrand's Theory.
Dana, Geology.
Geikie, Geology.
Green, " .
Philips, " .
Prestwick, " .
William's Geological Biology.
Leavitt, Peat and its Uses.
McFarlane's Coal Regions of America.
Thorpe, Coal,its History and Uses.

General Description of Coal Measure Formations.

Geologists tell us that all the surface rocks, and generally the substrata for thousands of feet were made by sedimentation, i.e. they were deposited from water on the floor of seas and oceans. Their material was eroded from the land surface and transfered by the streams to the sea. Here the sorting took place according to the size of the pieces; the largest falling first forming conglomerate and the finer grades making sandstones and shale. Finally the substances held in solution were allthat remained and the water became clear. Allthis, however, took place long before ocean depths were reached.

When the water is clear multitudes of lime secreting animals inhabit it, which assimilate the lime and carbon-dioxide from the water with which they construct calcium carbonate shells. When the animal dies his remains go to help build up a limestone. Various conditions enter to make the process more or less successfull.

A shale is a soft, loose rock, very, largely made up of clay but usually bearing sand and other materials as impurities. One containing much organic matter and therefore black or dark is called a bituminous shale. Aslate or slaty structure is like a shale in composition, but the term as used in the coal measures, signifies a peculiar, smooth cleavage along the planes of bedding. Strictly speaking a slate is a metamorphic rock cleaving at an angle with the bed plane, but the term is used for many strata of hardened shales of coal measure and other formations. Beds of clay are common in the coal measures. A fireclay is an old soil and subsoil, free from alkalies and consisting mostly of a hydrous silicate of alumina. A sandstone is made of sand grains cemented together more or less firmly by calcium, or iron carbonates or silica. Conglomerates are formed of coarse fragments of older rocks varying in size from pebbles to bowlders, which have rounded and worn by transportation, deposited and cemented by some of the usual methods. Limestones are

generally the remains of lime secreting organisms more or less mixed withclay, sand and organic matter, and all cemented together.

These rocks are not usually distinct but shade into each other so completely that they are difficult to classify. To obviate this trouble a compound nomenclature is used. When we have a sandstone carrying clay or organic matter, it is designated an argillaceous or bituminous sandstone; when a limestone contains sand or clay we have arenaceousor argillaceous limestone. If the rock has more foreign material than lime we call it calcareous sandstone or shale. In like manner we have shaly coals and coaly or bituminous shales. A bituminous rock is one whose material is partly of vegetable or animal origin and hence is a mixture of organic and in-organic substances. It is usually dark or black but will burn to a white, gray or red rock in high heat.

All the material except that of the coal and other partly organic strata was brought in by the streams from bordering hills and plains.Rocks previously laid down inseas were elevated to the station of land, and the rains, frosts and heat broke them down; then the streams carried the material again into the sea where it was once more laid down. Any rock crystalline or not, exposed to the action of the air and water may become part of the strata in the accumulating beds.

Mathematicians have calculated that the carrying power of a stream increases as the sixth power of the rate of flowing. If a stream be carrying fragments of a certain size and its velocity be checked one half, the carrying power is reduced to one sixty-fourth. Hence a very little slackening would cause much material to fall. This is just what happens when a river enters a sea or bay. The stream widens and looses much of its velocity and consequently of its load. This sedimentation is facilitated by a peculiar property ofthe mixture of sea and river water by which there is a tendency to precipitate all matter in suspension. Near the shore the deposition is much greater than farther out, so the littoral portion soon becomes quite shallow and eventually there is built up a delta surrounding the mouth of the river.

The great loading of the sea bottom causes it to settle and starts a deep seated flow

in the rocks, which ultimately menifests itself in avery slow rise of some land or mountain. During periods when much material is carried to sea the conglomerate extends farther out, and during periods of light transportation sandstones and shales will be formed much nearer the shore, so they may lie directly upon the conglomerate. Such a phenomenon is called shingling. Similar results come about by changes in elevation, modifying the shore line. These and many other forces make and modify coal measure rocks as will be noted in specific cases.

The elevation and depression which occurred in the floor of the sea in Coal Measure times was carried on in a slightly different method than that in earlier times. The coal areas seem to be ancient inland seas, hence they rest, not on true ocean bottom but on the continental areas, although up till that time and sometimes much later they were under sea water. Therefore there were no such great depths of water in the coal measure areas as now exist in the ocean. Perhaps on the contrary the water was never more than two or three hundred feet deep during the entire period, and usually much less. Of course the changes of level were very slow. Ifmodifications the same in time and extent were going on now we should probably be unable to detect any change except by the most accurate surveys at long intervals. The sum of the movements was a great downward progression, but there must have been some elevations, and afew periods of almost total quiet.

The changes of elevation indicated, affected large areas and were not confined to ridges or anticlines. Perhaps the whole field did not rise at the same time; a large part may have been rising while another part was sinking or stationary. Besides these movements of broad areas, smaller changes of level occurred in various parts of the basins. Faults of small displacement produced by coal seam contractions and crustal shrinkage, or irregularities in the make up of the rock strata came in to break up the continuity of the strata. Currents in the water, irregularities in the amount discharged from the rivers, winds &c., also had their influence in modifying land surfaces.

Most coal measure strata show proof of having been formed near the surface of water; but since they aggregate in some basins, twelve to fifteen thousand feet in vertical sect-

ion, there must have been enormous subsidence. This depression occurred as the material was heaped upon the lower rocks, and since the building up always took place at the top, it was near the surface of the water. When the building process predominated over the sinking the sediment soon filled the basin and the area became a marshy or swampy place suitable for the growth of water-plants. The same result may be attained by a gradual elevation of the deposited strata. Filling continued until the marsh would support the coal plants(moss, calamites, sigillaria, lycopods, ferns and others).

When the depression became more rapid than the accumulation of organic matter the sea drowned out the vegetation and began the deposition of sands and shales. These conditions by repetition gave rise to a succession of coal seams. In some fields there are only a few, in others scores. Owing to variations in rate of sinking, and in the distribution of marshes, islands and deep water, no stratum is continuous over the entire field. It is not likely that any coal seam exists which is uniformly developed over the whole field.

As has been previously stated much that was land area in a former period was open sea during coal measure times, and much more was wet and marshy. The land area was very much less than at present. This one fact tells us much about the climate of the Carbonic Era, which harmonizes with the hints given us elsewhere. If so much of the surface were water, the ocean currents would have better opportunity to distribute the heat absorbed under a tropical sun, to more northern or southern regions. The lack of land in the torrid zone made that part of the earth less able to absorb heat and more able to distribute it: hence there were not so great differences of temperature between places of high and low latitudes as at present, nor any such extremes of heat.

In consequence of the great water area and warm climate, evaporation was great. Water vapor in the air enables it to reflect again the dark heat rays from the earth which the sun has sent through the atmosphere once. Thus the heat is kept in the lower strata of air till absorbed by the earth. Dana tells us if all the carbon laid down as limestone and coal was in the air as carbon-dioxide at the opening of the period there would then have

been three parts carbon-dioxide to 1000 parts air, whereas now the ratio of 3 to 10,000 holds. If present, this gas would have the same influence on the temperature as the water vapor: but we do not need it, to account for the warm climate. There probably was no more of the gas in the air during coal measure times than now. It was being liberated from sedimentary rocks by metamorphism in many parts of the earth and was again being deposited as limestones and coal. Much more carbon is represented in the older limestones than in the coal. A great deal of the land now considerably elevated was then near the sea level, another circumstance conducive to higher temperature. To sum it all up the atmosphere was warm, temperate at least, almost all over the earth; it was more uniform throughout the year and day than now, and very humid.

This leads up to the subject of plants—the vegetation of the Coal Measures. Imagine a great extent of land and water each distributed in patches over the whole area; the land largely in the majority and comprising sandbars of silt and islands of firmer land. The water is in lagoons, small lakes, little streams with slow flow, and in pools and puddles. The land is mostly near water level forming flat or slightly rolling prairies. During heavy rains much of the land is flooded but the water soon drains off leaving most of the land dry enough to be traveled over. The country is so flat that drainage is imperfect and considerable portions of area are covered by perenial marshes.

On the highest land, conifers, progenitors of our cone bearing trees were quite abundant, with a thick undergrowth of ferns and creepers. Sedges and rushes, lycopods and ferns took the wettest uplands and the shores of the scattered ponds. All vegetation was very luxuriant and dense, for there was much rain, and the temperature was warm. The land plants occupying so much of the country were of prodigious size. Rushes (Calamites) were ten to fourteen inches through and sixty to eighty feet high. Our little scouring rushes are the only remnants of the genus. Lycopods (Lepidodendra &c) of which our club moss is a diminutive, were sometimes ninety feet high, branching towards the top into great club like limbs bearing a cone (Lepodostrobus) at the end. The spores of this genus of plants have accumulated and formed considerable beds of coal, as examples, in Ohio and Pennsylvania, and the Better Beds in England. Lycopods must have been very abundant.

On the ground under these shore plants flourished a luxuriant moss resembling our Sphagnum. Its nature was such that it absorbed water from the very humid atmosphere, and this, to such an extent that water could be squeezed from a handful of the moss as from a sponge. Probably the moss killed out other plants by its water and took possession of the land. Once give it a start in a moist climate and it will capture all available land reducing once productive fields to the condition of a swamp. This interesting moss so peculiar in its habits is given the credit of furnishing almost wholly the material for coal. Since trees were unable to grow with this moss on land it is not common to find trees in the coal. Frequently a peat moss or fen has taken the place of a forest destroyed by storm, or, in the case of the Roman invasions, by the axe. Thousands of acres of heavy-timbered land of Caesar's time are now marshes. In such cases of course the tree trunks are found at the bottom preserved by the water and remains of the moss.

Bear in mind that this was a land growth and not a water formation at all. Following out the analogy to the peat fields of Ireland and the continent, the moss may climb over small hills or even grow on the slopes of mountains and very rapidly cover everything. Frequently old Roman roads, bridges and viaducts in Great Brittain are now completely covered. Each year's growth adds to the previous mass a thin layer probably about one eighth of an inch, which does not decay as it would if exposed to the air, for it is litterally covered with water. One walking over a peat bog where the growing moss is still in place can often see water in his tracks; where the moss is pressed down, but will see none before him. If he shakes or stamps, the ground beneath him will quake. For this reason such bogs are called quaking earth, or quagmire.

If elevations and depressions occur or great floods of muddy water occasionally rush into this marsh, the deposited stratum becomes clayey and forms bituminous shale or shaly coal. The heaping of the peat continues sometimes to a thickness of two or three hundred feet, right on dry land; a low mound, with very gently sloping sides rising to the summit near the centre. When subsidence takes place shales and sands are laid down over the peat. Under the pressure thus brought to bear and the preserving influence of the water the changes of carbonization go on.

Where conditions are right, the moss grows out over the water, sometimes entirely covering a la-

goon with a rich, smooth, meadow-like carpet, at first of course not very strong, but as the growth continues the floating island gets firmer. Rushes and other semi-aquatic plants succeed in getting a footing among the moss, then bushes and finally the land plants and trees appear, till we have a veritable floating swamp-forest. Lesquereux tells of a series of lakes in Switzerland upon which such a forest had grown and was used as a pasture by several villages. One night in the year 1500 it went to the bottom and now in the clear water the tree trunks can be seen, while the growth is again covering the lake. Both these methods of peat formation are illustrated in the peat bogs of Europe but the former or land method is much more common. It is sometimes argued that the land method of peat formation resulted in bituminous and anthracite beds while the lagoon method produced cannel coal. Any pure pitchy peatmay produce cannel coal and hence it may come from the land peat bog if pure as well as from anywhere else. Bituminous coal may also come from the lagoon method.

Carbonization is the name given to theslow change which goes on in a stratum of peat or vegetable debris, under water and pressure until it becomes coal. It is certain that peat , lignite, and brown, bituminous and anthracite coal form a series all of plant origin. We are familiar with the rapid decomposition of logs, and leaves, into ash and CO_2 in the air, and we have also noticed that organic material under water, or shut away from the air does not decay in the same manner. There is a change in each set of conditions but they are not much alike. The former is an oxydation of the carbon and hydrogen, to two simple compounds, carbon-dioxide and water also some light hydrocarbons, which pass off into the air. The latter is a reduction but a much slower change than the other. The substance undergoes changes principally physical which reduce it to a pitchy or peaty consistency, a black or dark semi-fluid depending much for its fluidity upon the water it contains. The subsequent changes are chemical.

Woody tissue is a compound of carbon, hydrogen and oxygen but not nearly enough of the latter to satisfy the other elements; only 50%; that would take more than three times as much oxygen as is present. Coal contains a much lower percent ofoxygen; anthracite sometimes as low as one percent. This tells us that the changes suffered during carbonization were those of a reduction or the elimination of oxygen. Hydrogen is also lost and a very little carbon

A table from "Coal, Its History and Uses," by Thorpe and others shows this reduction. He considered the carbon as one hundred, and the other constituents, he figured from that. While the quantity of carbon in reality does decrease he has carried it through constant, but the reduction in hydrogen and oxygen is apparent.

TABLE 1.

Material.	Carbon.	Hydrogen.	Oxygen.	Wt. of 1 cu.ft.in lbs.
wood (average),	100	12.6	88.8	30
peat "	100	9.7	54.7	50
lignite "	100	8.6	40	70
brown coal(ave.)	100	7.4	29.7	75
bituminous "	100	6.4	15.4	80
anthracite "	100	2.6	2.6	90

I have said on a previous page that the material for a seam of coal grew in situ, became peat, and that it occupied many years in its accumulation. This would give the lower layers time to begin their changes. Even the reduction makes considerable progress sometimes while the moss is still growing on the surface. But nothing farther than peat is formed till the stratum is submerged and growth checked, and a load of sand and clays placed above it. In other words carbonization takes place in a wet stratum under pressure with the exclusion of free oxygen.

It is a well established rule that the greater the pressure the harder the coal; but good anthracite, except in rare cases, does not occur unless the strata have been more or less plicated, folded or arched. Anthracite is the result of metamorphism of bituminous coal, by pressure and heat. The greater the metamorphism the better the anthracite, other things equal. A few patches of anthracite occur in the west nearly in contact with eruptive rocks. It is supposed that the heat from the intrusion produced the metamorphism.

The most characteristic animals of the Coal Measures were Amphibians, here first introduced, according to our present knowledge of palaeontology. Vertebrates had been previously represented by fishes. Invertebrates were quite common as a subsequent table shows.

Discussion of the Illinois Coal Measures.

The coal field of Illinois is much more extensive than any in the east, and is peculiar in not having its surface folded into ridges or anticlines, hence there is no anthracite here. We have bituminous coal of all grades and some cannel coal. The north boundary follows a line eastward from central Rock Island county, to eastern La Salle, thence south to Chatsworth in Livingston county, and again eastward to the state line. Along the eastern boundary is the Wabash river which is still flowing on coal measure rocks in a considerable channel. The Ohio and Mississippi rivers have cut through all the coal measures laid down in their valleys, and frequently the bluffs have been stripped for two or three miles, to twenty-five miles back. The total area of coal measures in Illinois is about thirty-six thousand square miles.

The Coal Measures are divided into upper and lower measures by a very persistent bed of limestone known in different parts of the state as the New Haven or Carlinville Bed, or the Shoal Creek limestone. The lower measures occupy the larger area.

Rocks of the lower portion have been identified at frequent points around the entire area and in a number of deep borings in the interior. This shows that they have been developed all over the field but not uniformly. The strata in the eastern part of the state are continuous with those of western Indiana, and southern Iowa and northern Missouri contain strata evidently made about the same time as those in Illinois.

Before the beginning of coal measure times, open but not deep sea extended from the present Gulf of Mexico to the Arctic Ocean. An arm to the east through Tennessee and Kentucky occupied Pennsylvania, and from there one extended to Michigan. West from central Indiana to the Pacific, North America was inland sea with the exception of a large island on the present Ozark anticline and a great number of islands some nearly continental in the western mountain region. Thus it is seen that the Illinois coal field was along the border of the sea; a great littoral marsh four hundred miles wide, strewn with islands, little prairies, small lakes and swamps.

Coal Measure strata were laid down upon the eroded surface of Subcarboniferous rocks all

over the southern part of the state; and on Silurian and Devonian in the northern part.

The Mississippi probably flowed through the marshes to the Gulf at Cairo adding its detritus to the forming strata. When the waters were deep the river's mouth was near Rock Island; when shallow or during marshy times the river was a sluggish delta forming stream from Rock Island to the present Ozark uplift. The lower coals were continuous across its bed but were subsequently eroded.

The Gulf Stream, instead of taking a whirl in the Gulf and skimming out over the Florida Keys, took a direct course northwestward up the present Mississippi valley and a little west to the Arctic seas. This great warm current made much difference in the climate of the times.

Professor A.H.Worthen, former State Geologist, with a number of assistants has made a careful study of the Coal Measures, and has developed a system of classification for the coal seams which is elaborated in his reports of the Ill. Geol. Survey, especially in volumes six and seven. He reports sixteen seams, more or less persistent over the state, nine below the New Haven limestone and seven above; also several patches designated local beds. The latter are usually of small extent, and vary in thickness from a mere trace of bituminous shale to two feet of coal. Frequently black shales are found several feet thick. Some of Worthen's coal seams are frequently not marked by even a trace of bituminous shale--nothing to indicate the presence of a coal horizon. In other places every seam is developed and there scarcely any local bituminous strata to mislead.

These irregularities point most certainly to irregular movements in elevation and depression. We said that the whole area of the coal measure formation rose and fell together. This means that changes were not such as to destroy the general horizontality of the country, to make deep sea in one place and mountains in another; but had only slight variations. Bear in mind too, that the Gulf Stream lent its influence to modify the position of reefs and sand bars, and hence modified lagoons, and that several rivers sent their waters into the marsh with varying amounts of water and detritus; and also that the strata laid, had among them considerable material of irregular thickness which as it shrank would let the surface stratum down. All this would produce irregularities in the surface where the strata were forming. These

changes and those brought about by faulting and crustal contraction would modify the surface and the conditions of growth.

The term basin used in the discussions does not mean a lake basin but a coal basin, not a body of water but a nearly flat region of land, upon which the peat forming moss has grown. Such a basin would not necessarily have a rim, but on the contrary, must have places where the surface water can run out. It may be a plain or prairie surrounded by water and just above water level with no trace of a rim or sides, sufficient to cause it to contain water. It has been intimated in Professor Worthen's reports that only amateur geologists consider these coal basins. The very nature of the method of formation makes it necessary to consider them, to say nothing of the evidence furnished by analogous peat fields in recent times. They are almost always in basins. The Professor must have missed entirely the idea, for he says if basins were present then we should find the older rocks sticking through the coal measures to form their boundaries. Of course we do not find these at all. As I have said the coal basin is not analogous with the lake basin. Because there is a coal basin in one seam of coal it does not follow that there is another in the next seam above. From the borings and sections in the reports I have been able to outline a few of these basins.

There is no seam which is everywhere present but Worthen's most persistent seams, No.2 and No.7 show the basins nicely. No.7 is two or three feet thick in Marion, Effingham and Coles counties, and in Vermilion, from two to seven feet thick; in Macon, four inches; in Macoupin, Sangamon, and McLean, wanting; in Perry, one and one half feet thick. This outlines a basin extending from north Vermilion county, southwest to Perry and thirty or fourty miles wide. Fulton, Peoria, La Salle and Woodford counties present another basin in the same seam, I have found seam No.2 cut up into basins but they are not so clearly marked, because not nearly so many borings have reached a sufficient depth to furnish data regarding their boundaries. Many basins are much smaller than those outlined in No.7. They may vary from a half a mile to many miles in diameter.

No.4 gives a basin in Vermilion county which extends over into Indiana. It also presents quite a basin along the Illinois river valley. Worthen reports No. 4 six feet thick

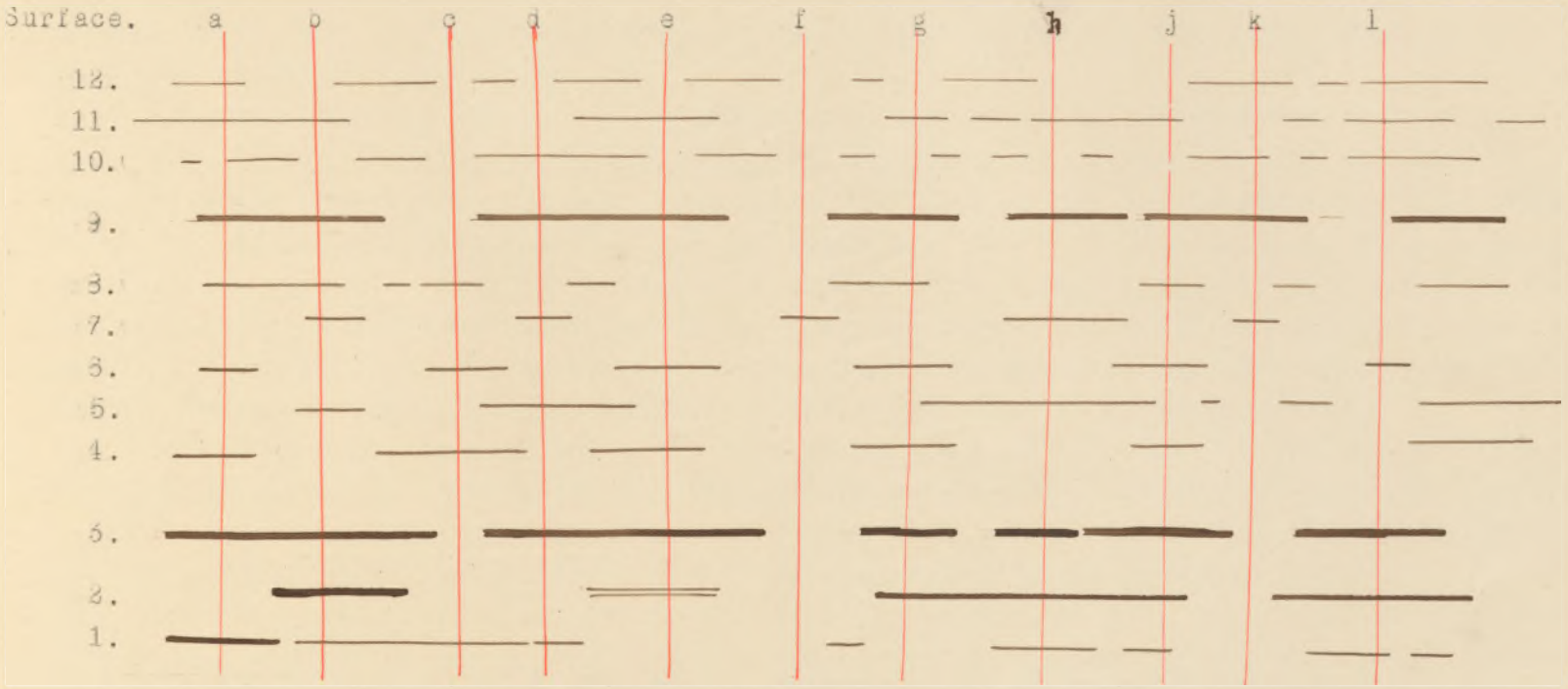
and eighty feet above No.3 in Fulton county. In McDonough county joining on the west, he reports No.4 eight inches thick and eleven feet aboveNo.3.This, if a correct identification,indicates a great thinning of strata where no other evidence and no cause for it comes to view. It seams probable that the basin of No. 4 does not extend so far west as McDonough county,but that the coals here designated Nos. 3 and 4 are one or both local.

Worthen repeatedly says in trying to correlate two seams of coal "if they are the same, and fossils seem to indicate it, there must have been a thinning"or"a thickening of strata here". But he often confesses that aside from the fact that the seam appears dislocated he has nothing to prove thinning.

Coals Nos.1and 2 are generally present either as coal or black shale but Nos.3 and 4 are quite irregular. No.5 is somewhat persistent but is often entirely wanting. No.6 and NO.7 occur as persistently probably as any and are sometimes missing. All the seams above the latter are quite variable. Nos.10 to 13 are often all present but sometimes there are two or three extra; then Worthen has trouble to decide which is local and which should bear the number. Sometimes all the seams are present in two neighboring counties, and there are considerable variations in thickness in the intervening strata,between two seams in one county and the same two (?) in ~~in~~ the next county. Will not the presence of these basins account for local differences in the quality of the coal from two openings of the same seam? In one place we find the coal contaminated with iron pyrites, in another it is shaly; in one region it has a clay parting, in another has a layer of cannel coal. Such differences could perhaps occur in the same basin,but I do not see how. It is easy to see how they may come in if we allow this conception of coal basins.

These things do not point to a fixed number of coal seams but quite the opposite. I do not think the number of coal horizons can be reduced below sixteen,but perhaps there are more than that. Probably two horizons have been given the same number, sometimes in the Survey Reports. Data from the borings to whichwe have access are too meagre and incomplete to absolutely prove this, but it seems very probable. An illustration may help to give clearness to the idea here.

FIGURE 1.



Beginning at the bottom of the section we have twelve coal horizons each one laid down horizontally; and to make the figure simpler they have been allowed to settle uniformly. The undulations so common in the coal measure strata(see Ill.Geol.Sur.vol.3,p.90 andvol.4, p.322),will not trouble us here. Such a section as this is impossible. Remember if the undulations due to earth movements were entered, it would increase the liability to error. The vertical lines a to l represent borings or shafts. The horizontal lines represent coal or shale sufficient to mark the horizon.

By a study of the logs of these borings with reference to the coal horizons penetrated it is seen that(a)recorded seven coal horizons; (b) nine; (c) four; (d) six; (e) six; (f) one; (g) seven; (h) seven; (j) eight; (k) five; (l) six. In but one instance are more than two thirds of the horizons recorded. Notice carefully Nos. 4,5,6,and 7.Nos. 4 and 6 are similar in structure, distance apart and quality of coal to Nos. 5 and 7. In no boring are more than two of these four horizons indicated. Grant that the strata thickened and thinned as they surely did and it becomes very easy to suppose from the borings that there are but two seams between No.5 and No.8. The supposition is shown by the section to be incorrect.

Since no trace of coal was found between No.9 and No.11, save in three out of eleven borings, it is natural to suppose that these three points are in local pockets. But in reality No.10 is more persistent than either Nos.4,5,6 or 7. Just such instances do occur in this state as are here illustrated. Worthen gives examples,(see vol.1,p.331).

Worthen says it is difficult to decide which he has, if only one of his No.5and No.6 are present. Jackson county logs give two seams in one part of the county which Worthen considers equivalents of two seams at Murphysboro on stratighaphic evidence. Just such an error may come in here as arose in the consideration of the previous figure,in spite of all evidence presented, Another peculiar case is that cited in the discussion ofbasins in seam No.4. But is the explanation he gives any more probable than that drawn from the figure?

Such matters as these might be easily settled if we had access to a section cut down through all the strata across the state; but cannot be satisfactorily answered from borings, as shown by figure 1, without a great many careful and complete borings and shafts.

In attempting to carry on this identification ofstrata we must keep in mind the following facts. Although coal horizons were as level as an Illinois prairie while forming, they may be badly bent in settling. Strata cannot be much disturbed relatively after subsidence, except by erosion. Coal seams "pinch out"where they came to islands or deep sea during their formation. By erosion a seam may be entirely removed, and the gap filled with deposited rock leaving no trace of either change, which a boring would record. All these and many other things enter and must have weight in determining strata, stratigraphically, and finally, results attained are often but guesses and should be so considered.

Fossils attest the presence of much animal and plant life during the Coal Measure period. Most of the limestones are abundantly supplied with Brachiopoda, Gasteropoda, Lamellibranchiata, and Cephalopoda. The shales are often quite fossiliferous. They are well supplied with plants, and, in some specially situated places, with insects, crustaceans and fishes. Corals, arachnids, annelids and echinoderms are found. Cephalopoda, Pteropoda, and Brachiopoda are all marine, and occur in the limestones and shales. But Amphibia, some Gasteropoda, many Crustacea, Insecta, Arachnida, Myriapoda and Plantae are terrestrial or fluviatile; and some Lamellibranchiata, Ganoids and Elasmobranchs are of doubtful position. The marineforms are not found except in certain thin formations, limestones, which make but a very small part of the coal measures.

This seems to point to a more or less fluviatile or terrestrial origin for most of the rocks of this period. Moreover, the almost complete displacement of one set of animals by the other many times during the period, and return to the same species, indicates alternations in conditions. The absence of extinctions, and great erosions, as well as the general sameness throughout the series indicate that there were no great changes, no revolutions or convulsions.

At the close of the text is a table of fossils. It contains the names of all the plants and animals found in the Illinois Coal Measures which I have been able to get together. Listing was commenced in the University cases and those names introduced by a red dash were found there. The State collections were listed next, and if any additional names or horizons were gotten, they are marked in black. Those marked with a green dash are from private collections.

The entire list has been arranged according to S.A.Miller's North American Palaeontology, and all duplicates cut out where his synonymy indicated them.

The columns to the right represent the strata between the sixteen coal horizons of Worthen, and the lines may represent arbitrarily the coal horizons. A check(x) after a name signifies that the fossil is found in that horizon, and the figure above indicates the county, according to the appended list. A horizontal line cutting several horizons shows that the label was indefinite, and that the fossil was found somewhere in the strata contained in that county, indicated by the number above. Ex. Alethopteris aquilina, Schloth. from the U.of I. collections was found in Grundy county (26), between the base of the Coal Measures and No.6. In McDonough county (47) above No.2; and in Perry county (56) between No.5 and No.6.

Among the methods of correlation, that of similarity of fossils is prominent. While no method can be used alone with accuracy, a harmony of several methods may give considerable satisfaction. Fossils, representing similar faunae, are not necessarily indicative of contemporaneous rocks.

The conditions may have been right for the formation of a certain terrane, with a given fauna or flora, in a certain part of the state at one time; and many years later (an indefinite period) the same conditions may have obtained in another part of the state, while in the first area things are entirely changed. Now perhaps the same species are contained in the second terrane as in the first. Are the two strata contemporaneous? Manifestly not. This condition of things is designated "homotaxis", and strata thus agreeing are said to be "homotaxial".

Bear in mind the changes mentioned came about very slowly and the migration was not that of individuals, but of species. Probably no animal's life was long enough to have been passed partly in one area, and partly in the other. Only a short journey occupied many generations. A group of animals inhabited one region where limestone was being formed. They pushed out their colony and took up a wider area after each generation. But sometime there began a change in elevation, and circumstances were modified. The colony spread in only one

or two adjacent directions, while the other sides did not find life so agreeable and hence the colony did not widen inthat direction but may have shrunk. This process continued for many successive generations and the colony had made considerable advancement. Perhaps the change was an elevation where they were, and a depression in the adjoining area. The life moved from the rising to the sinking portion occupying perhaps centuries in the change. Sands and clays gathered on the rising portion andfinally it emerged and became covered with vegetation, while the subsiding region received a layer of limestone or calcareous sandstone.

These changes are not always known to have taken place, but the theory is advanced as an explanation of the known facts. Some scientists do not seem to distinguish between theory and fact.

From the preceding paragraphs it will be seen that fossils do not characterize such formations as the strata of limestone and shales in our coal measures. They may be used in correlating groups but not these thin layers. The finer the subdivisions under consideration the less the information given by the fossils. Slight changes in the depth of water, in its temperature or saltness or in the conditions and kind of its sediment will sometimes make greater changes in the life than enormous revolutions have seemed to produce.

In examining the report on the fossils of such a series as the coal measures, it is no proof that a fossil does not exist at a certain horizon since no one has reported it. Even if the rocks do not contain traces of the organism it is not proof that the animal did not live during the time represented by a stratum. The circumstance proves, either that the search was not thorough enough to reveal the fossil, or that the conditions were not fulfilled for its preservation. Back of both these is the possibility that the organism did not live there but this is unproven. There are cases in which we can safely say "the organism did not exist here" or "it must have existed here", both statements based on analogy and on stratigraphic evidence.

From the large table No. 6 I gather the following summary, which shows how many species of each class are found in both Upper and Lower Measures, and the number from but one stratum.

TABLE NO. 2.

NO.	Class.	No. of species in Upper & Lower Measures.	No. of species in only one place.
1.	Plantae,	12	190
2.	Protozoa	1	2
3.	Coelenterata	5	5
4.	Echinodermata	5	5
5.	Bryozoa	6	5
6.	Brachiopoda	32	4
7.	Gasteropoda	31	66
8.	Cephalopoda	8	5
9.	Lamellibranchiata	37	14
10.	Annelida		1
11.	Crustacea	5	11
12.	Arachnida		3
13.	Myriapoda		3
14.	Insecta		9
15.	Pisces	5	18
16.	Batrachia		1
	Totals	147	314

With over eight hundred species from which to glean, one hundred and forty-seven occur in both Upper and Lower Measures, and three hundred have been reported in but one place. Of the latter list one hundred ninety are plants and twenty-two more belong to groups of animals absolutely terrestrial and hard to preserve, leaving only about 10% of the entire list which have ~~not~~ been found in but one locality, whose nature favors fossilation. How many of these will yet be found in other localities remains to be seen.

With a few exceptions those fossils reported from but one locality and one horizon come from the shale beds at Mazon Creek and Morris, both in Grundy county. This deposit was made under peculiar circumstances, and gives us hundreds of species not reported elsewhere in the state; and almost to a unit they are land forms.

Plants continued throughout the whole coal period as is evidenced by the immense banks of their remains in the extreme upper measures in White county. But they are so matted and mangled that species are hard to determine. Similar banks occur in many places all through the coal measures. If a form is found in one epoch and again in another later, it is considered as a form of all intermediate epochs, although not found there.

Some have supposed because insects were so abundant at Mazon Creek and were scarcely found anywhere else till Permian time, that these strata were of Permian origin. This does not prove a development of the Permian rocks here, unrecognized as such yet, but it does prove the presence of these types of life during Coal Measure times, and further, that the methods of preservation were wonderfully complete and indeed very successful in bringing to us a few samples of the life of these remote times.

There are only fifteen species of plants reported from the Upper Measures, and all but three or four of these from one county, but Worthen and others tell us of many beds of plant remains in Upper Measures. Lesquereux says lycopods are characteristic of Lower Measures, and ferns of Upper Measures. Several lycopods have been identified in the Upper Measures and over a hundred ferns in Lower Measures against fifteen in the upper beds. These are mostly from Mazon Creek just above coal No. 2. Occasional finds of insects and crustaceans in other places prove that they were more widely distributed.

Brachiopoda, the group of animals in which so much confidence is placed for strata correlation, leave us entirely in the dark, only four species having but one horizon, and thirty-two having been found in both upper and lower beds. Gasteropoda are a little better but here we have to take into account, that many were land species and could not well be preserved. Lamellibranchiata are classed with Brachiopoda in importance for correlation, and are nearly as silent on the subject, for out of one hundred eleven but fourteen species are found in one horizon only. Arthropoda are only found at Mazon Creek in any abundance; and Pisces, having no preservable parts but teeth, fin-spines, and sometimes dermal plates, give us five species found in both Upper and Lower Measures and eighteen found in only one horizon.

Professor Worthen gave (vol.1 p.6) a group of eleven fossils which he says are characteristic of a limestone a little above No.14(?). Upon examining the table I find their distribution as follows; Meekella striato-costata Cox, is identified by Worthen and others in five horizons ranging from coal No.6 to No.14 and in as many counties, also from three counties where horizons are not given; Pleurotomaria turbiniformis M.& W. three horizons ranging from No.8 to No.14 in three counties and in another county having both Upper and Lower Measures with no horizon given; Platyceras nebrascensis Meek, two horizons No.9 and No.14 in two counties; Athyris, Hall, Spirifer camerata Morton, S.lineata Martin, Spiriferina kentuckiensis, Shum., Orthis pecosi(carbonaria), Marcou, Terebratula bovidens, Morton, all from top to bottom of the coal measures; Chonetes verneuilanus, M.& P. from near bottom to near No.14; and Platyostoma peoriensis McChes., from No.7 to the top. So far as fossils are concerned there might be several horizons from No.6 to No.14 which would answer to the one in question. And this is not an isolated case. In vol. 6, p.15 is another. In vol.6, p.64 he correlates by Athyris subtilita and Spirifer camerata and fragments of Pinna. Seealso vol.6, p.70.

We are told that Leaia tricarinata is characteristic of No.7, (in vol.7, p. 44), but it has been identified all along from No.7 to No.16. In vol.1, p.502, are given seven characteristic species for the limestone over the Belleville coal each of which has been found abundantly all the way from No.1 to No.16, and one of them Spirifer camerata is quite abund-

ant in the Chester group. For other similar cases see vol.4,p.251, vol.5,p.272, and opposite page, and vol.5,p.291, and in short any place where he finds characteristic fossils in the Coal Measures. These, if followed out are sufficient to show that little confidence can be placed in fossils for identification of coal horizons, and their associated strata.

Fossils are useful in determining large groups of rocks, periods and epochs, but in Illinois Coal Measures it is impossible to tell, by fossils, whether a limestone or shale is associated with one coal or another. We have a series of facts, a good list of fossils and a splendid chance to study distribution, but it seems impossible to recognize a terrane by its fossils except as Coal Measure rocks.

List of Coal Measure Counties in Illinois.

1. Adams.
2. Bond.
3. Brown.
4. Bureau.
5. Calhoun.
6. Cass.
7. Champaign.
8. Christian.
9. Clark.
10. Clay.
11. Clinton.
12. Coles.
13. Crawford.
14. Cumberland.
15. DeWitt.
16. Douglas.
17. Edgar.
18. Edwards.
19. Effingham.
20. Fayette.
21. Ford.
22. Franklin.
23. Fulton.
24. Gallatin.
25. Green.
26. Grundy.
27. Hamilton.
28. Hancock.
29. Henderson.
30. Henry.
31. Jackson.
32. Jasper.
33. Jefferson..
34. Jersey.
35. Johnson.
36. Knox.
37. LaSalle.
38. Lawrence.
39. Livingston.
40. Logan.
41. Macon.
42. Macoupin.
43. Madison.
44. Marion.
45. Marshall.
46. Mason.
47. McDonough.
48. McLean.
49. Menard.
50. Mercer.
51. Monroe.
52. Montgomery.
53. Morgan.
54. Moultrie.
55. Peoria.
56. Perry.
57. Piatt.
58. Pike.
59. Putnam.
60. Randolph.
61. Richland.
62. Rock Island.
63. Saline.
64. Sangamon.
65. Schuyler.
66. Scott.
67. Shelby.
68. Stark.
69. ST. Clair.
70. Tazewell.
71. Vermilion.
72. Wabash.
73. Warren.
74. Washington.
75. Wayne.
76. White.
77. Will.
78. Williamson.
79. Woodford.
80. Union.
81. Pope.

Plantae.	1	2	3	4	5	6	7	8	9	10	12	12	13	14	15	18
Alethopteris																
— aquilina, Schloth.		47. 26. x			56 x											
falcata, Lesq.		26. x														
— helenae, Lesq.		50														
— lonchitica, Schloth.	24 x	26 x														
— pennsylvanica, Lesq.		26. x														
Annularia																
— calamitoidea, Schimp.		26 x														
— fertilis, Sternb.		26 x														
— inflata, Lesq.		26 x														
— longifolia, Brogn.		47 26 x	36 x													
— sphenophylloides, Zek.		47 26 x	36 x		56 x	37 x										
tuberculata, Sternb.		26 x														
Asterocarpus																
grandis, Lesq.		26 x														
Asterophyllites																
— crassicaulis, Lesq.		26 x														
= equisetiformis, Schloth.		77 47 26 x				56 x										
— foliosus, Lind. & Hutt.		26 x			56 x											
— hymenophylloides,		26 x														
— longifolius, Brogn,		26 x			56 x											
— rigidus, Sternb.		26 x														
— sublaevis, Lesq.		26 x														

Plantae.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Pechera grandis, Sternb.			26 X													
Bornia radiata, Brogn.			47 X													
Calamites approximatus, Sternb.		50	47 X 26			64	56 X 71	76								
arenaceous,								76								
histriatus, Lesq.								76								
canniformis, Schloth.			47 26 X													
cisti, Brogn.			26 X					76								
cruciatus, Brogn.							56 X									
pachyderma, Brogn.	X					31 X										
ramosus, Artis.			26 47 X			31 X	56 X									
suckovi, Brogn.			47 26 X					76	39	53	20					
undulatus, Brogn.			47 X													
Callipteridium inflatum, Lesq.			26 X													
Callipteridium massilioneum, Lesq.			26 X													
oweni, Lesq.			26 X													
rugosum, Lesq.			26 X													
sullivanti, Lesq.			47 26 X			31 X										
Cardiocarpon southwelli,		62														
marginatum, Artis.		50.														
Carpolites cistula, Lesq.			47 X													

Plantae.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Carpolites corticosus, Lesq.		26 X														
fasciculates, Lesq.					76											
— persicaria, Lesq.						31 X										
Caulopteris — acanthophora, Lesq.		47 26 X														
cisti, Progn.		26 X														
intermedia, Lesq.			65 X?			65 X?										
— obtecta, Lesq.		47 26 X		23.												
— tuberculatus,						56 X										
Cordaianthus — bracteatus, Lesq.		26 X														
Cordaites — diversifolius, Lesq.		26 47 X														
— borassifolius, Sternb.		47 26 X				56 31 X										
— serpens, Lesq.	50															
Cyclopteris — elegans, Lesq.			53													
— hirsuta, Lesq.						31 X										
— orbicularis, Progn.		26 X														
Dictiopteris — rubella, Lesq.		31 X	43			56 X										
Equisetites — occidentalis, Lesq.		26 X														
Halonia — tortuosa, Lind.& Hutt.					64											

Plantae.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Hymenophyllites delecatulus, Brogn.		26 x														
— guthieranus, Unger.		47 26 x														
myriophyllus, Brogn.		26 x														
pinnatifidus, Lesq.		47 x					56 x									
tenuifolius, Brogn.		26 x														
Lepidocystis — bullatus, Lesq.		26 x														
— vesicularis, Lesq.		26 47 x				56 x										
Lepidodendron = aculeatum, Sternb.		26 x	37													
— carinatum, Lesq.		80														
= clypeatum, Lesq.	62 x	26 47 x	65													
— crenatum, Sternb.		50														
— cruciatum, Lesq.		26 x														
— dichotomum, Sternb.		47 26 x	37				71 x									
diplostegiodes, Lesq.		47 x														
elegans, Sternb,		47 26 x					71 x									
— formulatum, Lesq.							56 x									
gracilis, Lind.& Hutt.		47 x														

8

Plantae.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Lepidodendron																
— greeni, Lesq.		50														
— longifolium, Brogn.		26 x														
= modulatum, Lesq.	62 x	26 x														
— morrisanum, Lesq.		26 x														
— obovatum, Sternt.	81 62 x	47 26 x														
— obscurum, Lesq.	81 x															
radicans, Lesq.						56 x										
rigens, Lesq.		26 x														
— rimosum, Sternt.		26 x														
— scutatum, Lesq.		47 x														
simplex, Lesq.		47 x				56 x										
= sternbergi, Brogn.		26 x 50														
— stigmaroides,						56 x										
— tijoui, Lesq.						56 x										
— turbinatum, Lesq.	81 x															
— veltheimanum, Sternt.	81 x	47 50 26 x														
— wortheni, Lesq.		47 x				31 x										
Lepidophloios																
auriculatus, Lesq.						56 x										
laricinus, Sternt.		26 x														

Plantae.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Lepidophloios																
— macrolepidotus, Goldenb.		47 x														
— obcordatus, Lesq.		47 x					56 x									
— protuberans, Lesq.		26 x														
Lepidophyllum																
— auriculatum, Lesq.		47 x				56 x										
— brevifolium, Lesq.		26 x														
— corticosum,		26 x														
— majum, Brogn.		43 ~~26~~ x					71 x									
— oblongifolius, Lesq.		26 x														
— rostellatum, Lesq.		26 x														
— striatum, Lesq.		26 x														
Lepidostrobus																
— connivens, Lesq.		26 x														
— foliaceus, Lesq.		31 26 x														
— hastatus, Lesq.		26 x					47 x									
— lanceolatus, Brogn,		47 26 x														
— longifolius, Daws.		26 x														
— oblongifolius, Lesq.		26 x														
ornatus, Parkinson.		26 x														
— ovatifolius, Lesq.		26 x														
— princeps, Lesq.		26 47 x					56 x									

Plantae.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Lepidostrobus																
— truncatus, Lesq.		26 x														
variabilis, Lind.& Hutt.						71 x										
Lycopodites																
annulariafolius, Lesq.		26 x														
asterophyllitifolius, Lesq.		26 x														
cavifolius, Lesq.		47 26 x														
meeki, Lesq.		26 x														
uncinatus, Lesq.		47 x														
Macrostachya																
lanceolata, Lesq.		26 x														
Megaphyton																
— maclayi, Lesq.		26 x				56 x										
Neuropteris																
angustifolia, Brogn.		26 x														
— callosa, Lesq.		31														
— capitata, Lesq.		26 x 31														
— clarksoni, Lesq.		26 x														
— collinsi, Lesq.		26 x														
— coriacea, Lesq.		26 x														
crenulata, Brogn.		26 x														
— decipiens, Lesq.		26 x														
desori, Lesq.		26 x														
— eveni, Lesq.		26 x			31 x											

Plantae.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Neuropteris																
— fasciculata, Lesq.		26 x			53 x											
— fimbriata, Lesq.		26 x	31													
— flexuosa, Sternb.		31 26 x														
— heterophylla, Brogn.	62 x	26 x														
= hirsuta, Lesq.		47 31 24 26 x x	64 42 12 38 42.				66 37 x 71 x									
— inflata, Lesq.		26 x														
— loshi, Brogn.		31 26 53 x							75 76.							
microphylla, Brogn.		26 x														
— obliqui,		26 x														
pachyderma, Lesq.		26 x														
— plicata, Sternb.		26 x					20									
— rarinervis, Bunb.		31 47 26 x	36 x		66 x	71 x										
— reniformis, Brogn.		31 x														
= rotundifolia, Brogn.		43 26 x							76							
— subfalcata, Lesq.			31													
= tenuifolia, Sternb.		26 47 x	53						76							
— trichomanoides, Brogn.		31 x														
— verbenaefolia, Lesq.		26 x														
— vermicularis, Lesq.		31 26 x					71 x									

Plantae.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Neuropteris			26													
— villiersi, Brogn.			31 x													
Odontopteris aequalis, Lesq.			26 x													
— heterophylla, Lesq.			47 x													
— polymorpha,			26 x													
— schlotheimi, Brogn.			26 x			71 x										
— subcuneata, Punt.			26 31 x													
— wortheni, Lesq.			26 31 x													
Oligocarpia			31													
— alabamensis, Lesq.			x													
— guthieri, Goepp.			26 x													
Pachypteris gracillina, Lesq.			26 x													
Pecopteris																
— abbreviata, Brogn.			26 x													
— acuta, Brogn.			26 x	68 x		65 x										
aequalis, Brogn,			~~26~~ x			65 x										
— arborescens, Schloth.			47 26 x	68 x	42	11										
— arguta, Sternb.			26 x													
aspidoides, Brogn.			26 x													
— bucklandi, Brogn.			37 26 x			71 x										
candollana, Brogn.			26 x													
cisti, Brogn.			26 x													
— clarki,			26 x													

Plantae.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Pecopteris cristata, Gutb.		26 x														
— cyathea, Schloth.		42														
— dentata, Brogn.		31 26 x														
elegans, Goepp		26 X														
emarginata, Goepp.		26 x														
— erosa, Gutb.		26 x														
flavicans, Presl.		26 x														
halli, Lesq.		26 x														
— hemiteloides, Brogn.		26 x														
lanceolata, Lesq.		26 x														
— lepidorachis, Brogn.		26 x														
— longifolia, Brogn.		26 x														
— lyratifolia, Goepp,		26 X														
— miltoni, Artis.		26 x					71 x									
— oreopteroidea, Schloth.		47 26 x	68 x				71 x									
— platyrachis, Brogn.		31 x														
— penniformis, Brogn.		26 x														
plumosa, Artis.		47 26 x					56 x									
— polymorpha,		26 x	36 x							76						

Plantae.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Pecopteris																
— pteroides, Schloth.			26 x													
— rarinervis, Font.& White.			26 x													
— serlii, Brogn.			26 x				71.									
serpillifolia, Lesq.			26 x													
— solida, Lesq.			26 x													
= squamosa, Lesq.			47 26 x													
stellata, Lesq.			26 x													
— strongi, Lesq.			47 26 x													
— unita, Brogn.			47 26 x				56 x									
= vestita, Lesq.			26 x	44												
— villosa, Brogn.			47 26 x	31 68. 36 x		42. x	56 x	36 71 x								
Rinnularia			31	37												
— capillacea, Lind.& Hutt.			47 26 x	36 x			56 x									
— ficoides, Lesq.				27												
— peracuta,				11.												
Pseudopecopteris																
abbreviata, Lesq.			26 x													
— callosa, Lesq.							31 x									
hymenophylloides, Lesq.			26 x													
irregularis, Sternb.			47 x													
latifolia, Brogn.			26 x													

Plantae.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Pseudopecopteris																
— mazonana, Lesq.			26 x													
muricata, Brogn.			26 x													
newberryi, Lesq,			26 x													
— nervosa, Brogn.			26 x				31 x									
obtusiloba, Brogn.			31 x													
pluckeneti, Schloth.			26 x													
sillimani, Brogn.			26 x													
spinulosa, Lesq.							56 x									
— sulcrenulata, Lesq.			26 x													
— subnervosa, Boem.	31 x															
trifoliata, Artis.			47 x													
Rhabdocarpus																
— amygdaliformis, Goep.&Berg.			47													
— clavatus, Sternb.			26 x													
— jacksonensis, Lesq.			26 31 x													
— mammillatus, Lesq.			26 x		55 x											
— multistriatus, Prestl.			26 47 x													
Rhachiopteris																
affinis, Lesq.			26 x													
selago, Lesq.			26 x													
Rhacophyllum																
— adnascens. Lind.&Hutt.			47 26 x													

Plantae.	1 2	3 4	5	6	7 8	9 10	11 12	13 14	15 16
Rhacophyllum arborescens, Lesq.	26 x								
— clarki, Lesq.	26 x								
— filiciformé, Gutb.	26 x 47								
— flabellatum, Sternb.	31 x26 50								
hirsutum, Lesq.	26 x								
inflatum, Lesq.				56 x					
— lactuca, Sternb.	26 x								
— molle, Lesq.	26 x								
— strongi, Lesq.	26 x								
thallyforme, Lesq.	47 26 x								
Selagimites (?) Brogn.		68 x							
Sigillaria alternans, Brogn.	26 x								
— annulariformis,	26 x								
brardi, Brogn.	47 x			56 71 x					
— camptonaemia,	26 x								
— cavifolius, Lesq.		47							
— corrugata, Lesq.		50 37							
— elegans, Sternb.		31							

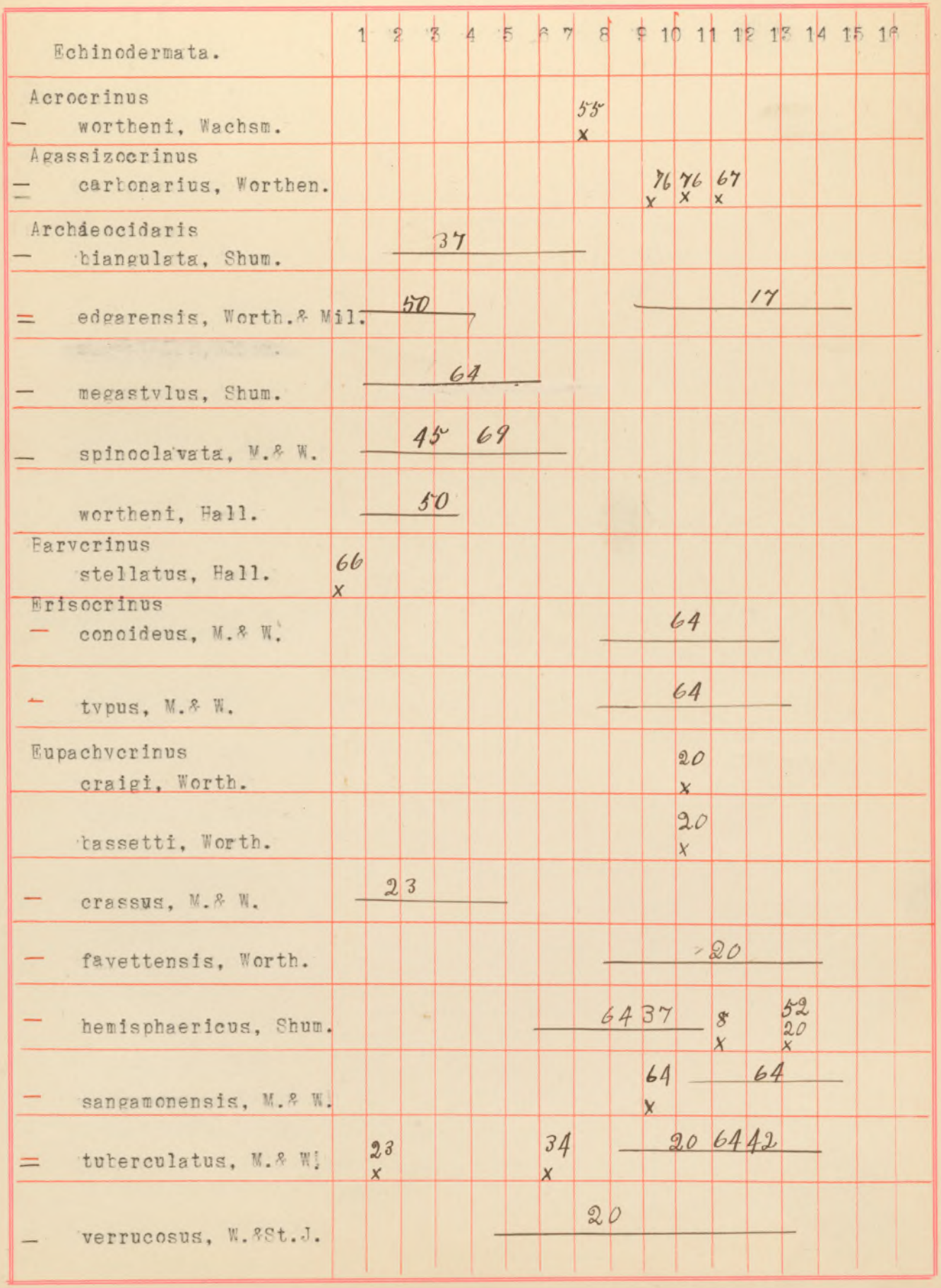
Plantae.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Sigillaria,																
— elongata, Brong.					55											
= intermedia, Brogn.		26 x							76							
— laevigata, Brogn.				50												
— marginata, Lesq.				58												
= massiliensis, Lesq.				47 37												
— menardi, Brogn.				47 x		55	63									
— monostigma, Lesq.				47 26 x			71 56 x									
— sculpta, Lesq.				31			56 x									
spinulosa, Germ.									76.							
— tessellata, Sternb.				26 47 x			56 x									
— yardleyi, Lesq.				37												
Sigillaroides radicans, Lesq.				26 x												
Sorocladus asteroides, Lesq.				26 x												
— saggitatus, Lesq.				26 x												
— wortheni, Lesq.				26 x												
Sphenophyllum cornutum, Lesq.				47 x												
— emarginatum, Brogn.				47 26 x			56 56 x									
filiculme, Lesq.				26 x												
— schlotheimi, Brogn.				47 26 x	68 x		56 x									

Plantae.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Sphenopteris																
— acutiloba,	62 x															
alata, Brogn.		47 26 x														
— callosa,		31														
— choerophylloides, Brogn,		26 47 x				68 x										
— cristata, Brogn.		26 50														
— elegans, Brogn.		26 x														
— furcata, Brogn.		26 x														
— gracilis, Brogn.	62 x	26 x														
— inflata,		26 x														
— lesquereuxii, Newb.		31														
— mediana, Lesq.		26 x	36 x													
— mixta, Schimp.		47 26 x														
pseudomurravana, Lesq.		26 x														
— palmata,		47?							47?							
— pauperculata, Lesq.								56 x								
— pinnatifidus,		47?							47?							
— rigida, Brogn.		47 26 x														
— scaterrima, Lesq.		26 x														
— solida, Lesq.		26 x	47													

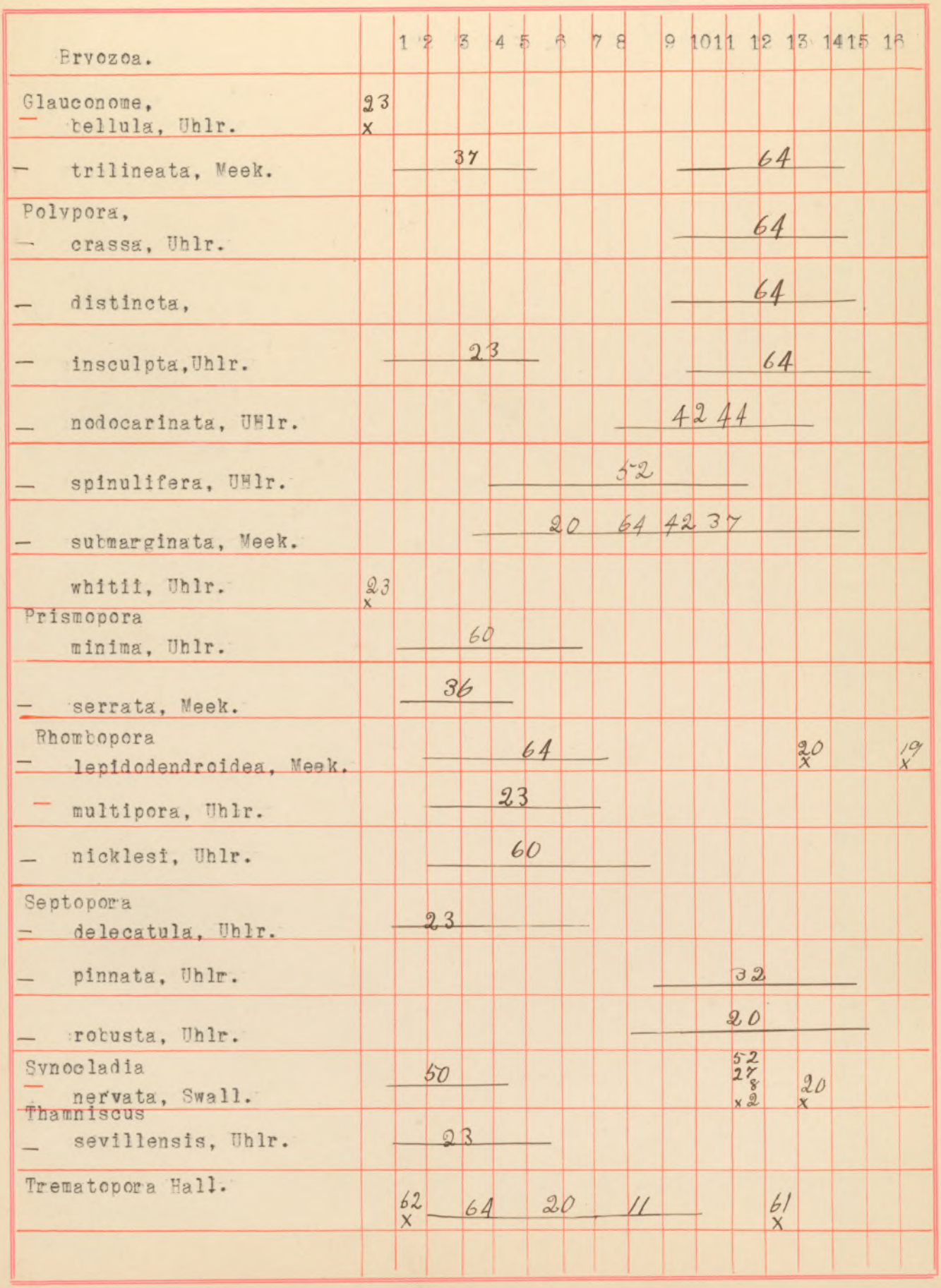
Plantae.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Sphenopteris spinosum, Goepp.			47 x													
splendens, Daws.			47 26 x													
— subalata, Weiss.							56 x									
tenella, Brogn.				68 x												
trichomanoides, Brogn.			26 x													
— tridactyllites, Brogn.			50 26 x				56 x									
Spirangium — appendiculatum, Lesq.			26 x													
— corrugatum, Lesq.			26 x													
— prendeli, Lesq.			26 x													
Stemnopteris — insignis, Lesq.							56 x									
— wortheni, Lesq.								76								
Sternbergia — transversa, Steinh.								76								
Stigmaria — eliptica, Lesq.							56 x									
— ficoides, Brogn.	73 62 x		23 47 x				71 x									
— latilcta,							56 x									
— stellaris, Lesq.			26 x													
umbomata, Lesq.			47 x													
Stigmaroides, — eveni, Lesq.			26 x	36 x												
linearis, Lesq.			26 x													
rugosus, Lesq.			26 x													

Plantae.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Stigmaroides																
— truncatus, Lesq.		26 X														
— tuberosus, Lesq.		26 X														
villosus, Lesq.		26 X														
Syringodendron																
— cyclostigma, Brogn.		43		52												
— pachyderma, Brogn.	80 X		31													
pescapreoli, Sternb.									76							
Taonurus																
marginatus, Lesq.									17 71 X							
Trigonocarpum																
— juglans, Lesq.		31 X														
= noeggerathi, Sternb.		26 X		51 X												
— rostellatum, Lesq.									76							
Ulodendron																
— elipticun, Sternb.		47 26 X														
elongatum, Lesq.																
majum, Rhode.		26 47 X														
punctatum, Lind.& Hutt.		26 X														

Protozoa.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Batospongia spicata, Uhlr.	23 x															
Fusilina cylindrica, Fischer.							55 x	71 x				10 x	10 x	10 x		14 x
— gracilis, Meek.							53 x	64 x								
— ventricosa, M.& H.							63 26 x									
Coelenterata.																
Axophyllum infundibulum, Worthen.			37									9 x				
— rude, W.&St.J.		69						64 x								
Campophyllum torquum, Owen.		46	49					42 x								
Chaetetes cartonarius, Worth.							69 x		20							
— milliporaceus, Edw.& Haime.					25 42 23 x		23 x	55 x								
Cyathaxonia distorta, Worth.		50		37				55 x								
— profunda, Edw.& Haime.			37													
Hyalostella delecatula, Uhlr.	23 x															
Hystrispongia cartonaria, Uhlr.	23 x															
Lophophyllum proliferum, McChes.			55 x	53 x			55 x	37 55 63 x	42 64 17 x	76 x	2 71 x	76 75 72 38 27 x	73 61 38 17 13 10 x	61 52 20 9 x	67 32 20 10 x	19 14 x
Stenopora signata, Uhlr.			69													
Syringopora multattenuata, McChes.										64 x	42 x					
Zaphrentis ? Raphin.		50														


Echinodermata.
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
Acrocrinus
— wortheni, Wachsm.
55
Agassizocrinus
= carbonarius, Worthen.
76 76 67
Archaeocidaris
— biangulata, Shum.
37
= edgarensis, Worth.& Mil.
50
17
— megastylus, Shum.
64
— spinoclavata, M.& W.
45 69
wortheni, Hall.
50
Barycrinus
stellatus, Hall.
66
Erisocrinus
— conoideus, M.& W.
64
— typus, M.& W.
64
Eupachycrinus
craigi, Worth.
20
tassetti, Worth.
20
— crassus, M.& W.
23
— favettensis, Worth.
20
— hemisphaericus, Shum.
64 37
8
52
20
— sangamonensis, M.& W.
64
64
= tuberculatus, M.& W.
23
34
20 64 42
— verrucosus, W.&St.J.
20

Echinodermata.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Graphiocrinus carbonarius, M.& W.											64					
Hydreionocrinus acanthophorus, M.& W.		23 x								x						
discus, M.& W.			37							64 x						
mucrospinus, McChes.									64 x							
Menocrinus adamsi, Worth,									55 x							
Poteriocrinus lasallensis, Worth.								37								
macoupinensis, Worth.								42								
Bryozoa.																
Acanthocladia fruticosa, Uhlr.											64					
Archimedes owenanus, Hall	66 x															
Chainodictum laxum var. minor, Uhl.			23													
Diplopora biserialis, Uhlr.			23													
Fenestella delecata, Meek.	23 x															
inequalis, Uhlr.											64					
minima, Uhlr.			23													
perminuta, Uhlr.			23													
sevillensis, Uhlr.			23													
wortheni, Uhlr.	26 x															
Fistulipora nodulifera, Meek.				67												


Bryozoa.
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
Glauconome,
— bellula, Uhlr.
23
x
— trilineata, Meek.
37
64
Polypora,
— crassa, Uhlr.
64
— distincta,
64
— insculpta, Uhlr.
23
64
— nodocarinata, UHlr.
42 44
— spinulifera, UHlr.
52
— submarginata, Meek.
20 64 42 37
whitii, Uhlr.
23
x
Prismopora
minima, Uhlr.
60
— serrata, Meek.
36
Rhombopora
— lepidodendroidea, Meek.
64
20
x
19
x
— multipora, Uhlr.
23
— nicklesi, Uhlr.
60
Septopora
— delecatula, Uhlr.
23
— pinnata, Uhlr.
32
— robusta, Uhlr.
20
Synocladia
— nervata, Swall.
50
52
27
8
x 2
20
x
Thamniscus
— sevillensis, Uhlr.
23
Trematopora Hall.
62
x
64
20
11
61
x

Brachiopoda.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Athyris = missouriensis, Swall.		69	51													
— sublamellosa, Hall.		69			23											
= subtilita, Hall.	71 x	73 67 47 24 23 x	50 36 29 x	55 53 5 x	55 x	78 49 42 x	58 56 51 49 34 x	37 63 24 78 9 71 55 x	64 42 71 x	76 39 37 24 22 11 x	71 37 x	52 42 38 37 9 2 x	17 13 9 8 71 x	61 52 20 9 x	32 20 9 x	18 13 12 x
Camarophoria — giffordi, Worth.									55 x							
Chonetes = flemengi, N.& R.			23		37 x		55 36 x			44		29 x	37 13 x	52 20 x	67 20 x	19 x
— granuliferus, Owen.		50	36 69	37 x			34 56 x			76 2 x						10 x
= mesolobus, N.&R.		50 73 62 x	2, 4 55 36 3 x	31 55 65 47 36 x		55 78 24 x	69 79 56 55 51 42 37 34 x	55 71 63 x		37 74 x				9 x	32 x	
— millepunctatus, M.& W.			11							44 x						
— smithi, N.& R.					23	37	61 51 69 x									
variolatus, DeKon.										2 x	2 x	8 x	61 x		67 x	
= verneuilanus, N.& R.		64	42	55							2 x	76 x	61 75 x	52 x	9 x	
Discina = nitida, Philips.		50 66 58 62 x		55 1 47 x	49 23 58 65 x		64 68 42 x	71 x		76 x	71 x	38 x	61 x			
Lingula = mytiloides, Sow.			23					64								
— scotica, Dav.		50														
— umbonata, Cox.		66 x	23 36 x	31 x	48 55 x		64 71 x									
Meekella — striato-costata, Cox.				60		69	56 x	37		2 x			17 x	20 x	9 x	

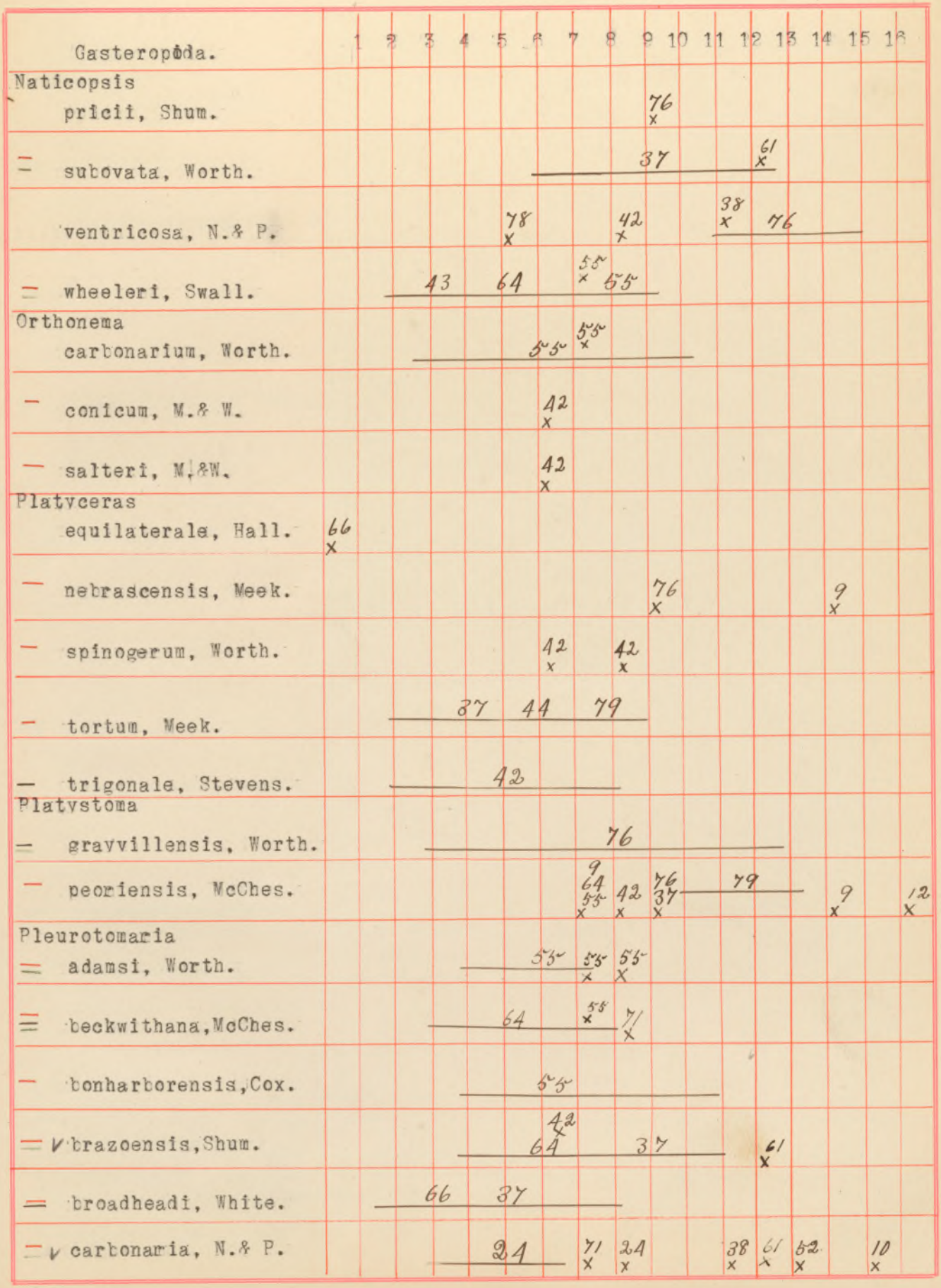
Brachiopoda.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Orthis																
— pecosi, Marcou.	23 x	37						71 x	76 71 x	37	76 75 x	61 38 x	8 9 x	20 6 9 x		19 x
— resupmoides, Cox.	60															
— robusta, Hall.		69														
Productus																
— aequicostatus, Shum.		36							2							
— boonensis, Swall.			64						2 x					52 x		19 x
= calhounensis, Swall.			37 64													
— cora, D'Orb.		28		31		23										
— costatus, Sow.	50		43 69							37						
						42 56 x	49 x 55 57 x	71 x	64 x	11 74 76 x	71 x	9 8 75 x	13 61 9 52 10 75 x	20 52 10 x		19 x
— lasallensis, Worth.	60						37									19 14 x
= longispinus, Sow.			69 65 23							79						
			50 58			55 78 63 56 49 24 x	55 57 49 42 34 25 x	55 71 63 x	64 42 17 x	76 74 39 37 24 22 11 2 x	71 2 x	78 75 52 42 38 2 x	61 13 9 8 x	61 52 20 9 8 x	67 32 7 x	13 14 19 x
	73 62 66 24 x	31 x	55 53 37 36 x	39 x												
= muricatus, N.& P.	73 62 x	23 50 x 3	36 30 23 47 53 x 1	65 23 x		55 x	42 x									
— nanus, M.& W.	23 x		68													
= nebrascensis, Owen.		36 x	24 36 30 x			56 x	55 x		64 x	64 37 76 2 x	27 42 x	8 52 2 x	61 52 x	8 20 52 x	67 20 x	
— parvus, M.&W.	60															
= pertenuis, Meek.				64			44					61 x			10 x	
= prattenanus, Norw.	60 50 62 23 x	36 23 x	67 68 69 55 65 36 30 x 47			55 78 56 x	51 42 36 x		64 x	79 76 64 11 37 x 2	74 42 27 x	8 x	72 61 52 13 9 x	52 20 8.9 x	67 32 x	67 10 x 67 19 x

Brachiopoda.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Productus																
= punctatus, Mart.	23	50	53	56	51				37		8	61	10	52 20	10	67 19
— rogersi, N.& R.										71		61				
scabriculus, Mart.			53				71	71		71						19
— semireticulatus, Mart.	66 73		53			34	63		76			61	9			19
= symmetricus, McChes.			37	67		52		69		64						
— watashensis, N.& R.			69													
Retzia		50 31														
= mormoni, Marcou.	23	29	23			34 49	55 49	42 71	72	71		61 82	8	67 20		14 19
Rhynchonella																
= illinoiensis, Worth.		60	55				55									
— ottumwa, White.				9												
= rockymontana, Marcou.	62 73	36	64						76				9			
= uta, Marcou.		50	37	55		55 42 23	79	42	76 22 2	72	38 42 62	61				67 14 19
Spirifera		50 69 31				55 78		40			72 71		37			
= camerata, Morton,	73 62 24	78	55 53 36			42 49 56 51	78 71 63 58	55 71 64 42	76 74 39 11	76 39 71	71 75 52 8	61 52 17 13 10 9	61 52 10 9 8	52 20 10 9 8	32 19 10 9	19 14 12
— fultonensis, Worth.		60	23													
= lineata, Martin.		65 47 50	47 5	65		78 51 49 34 56 25	55 37 51	17	37 22 2	39		71 17	61 20	40 9		13 14 19
— multigranosus, Worth.			64													
= plano-convexa, Shum.		29	69 55 36 47				9	74 17 42	74 39 76	71	38 27	61 8 9	61	67 20 32		19 14

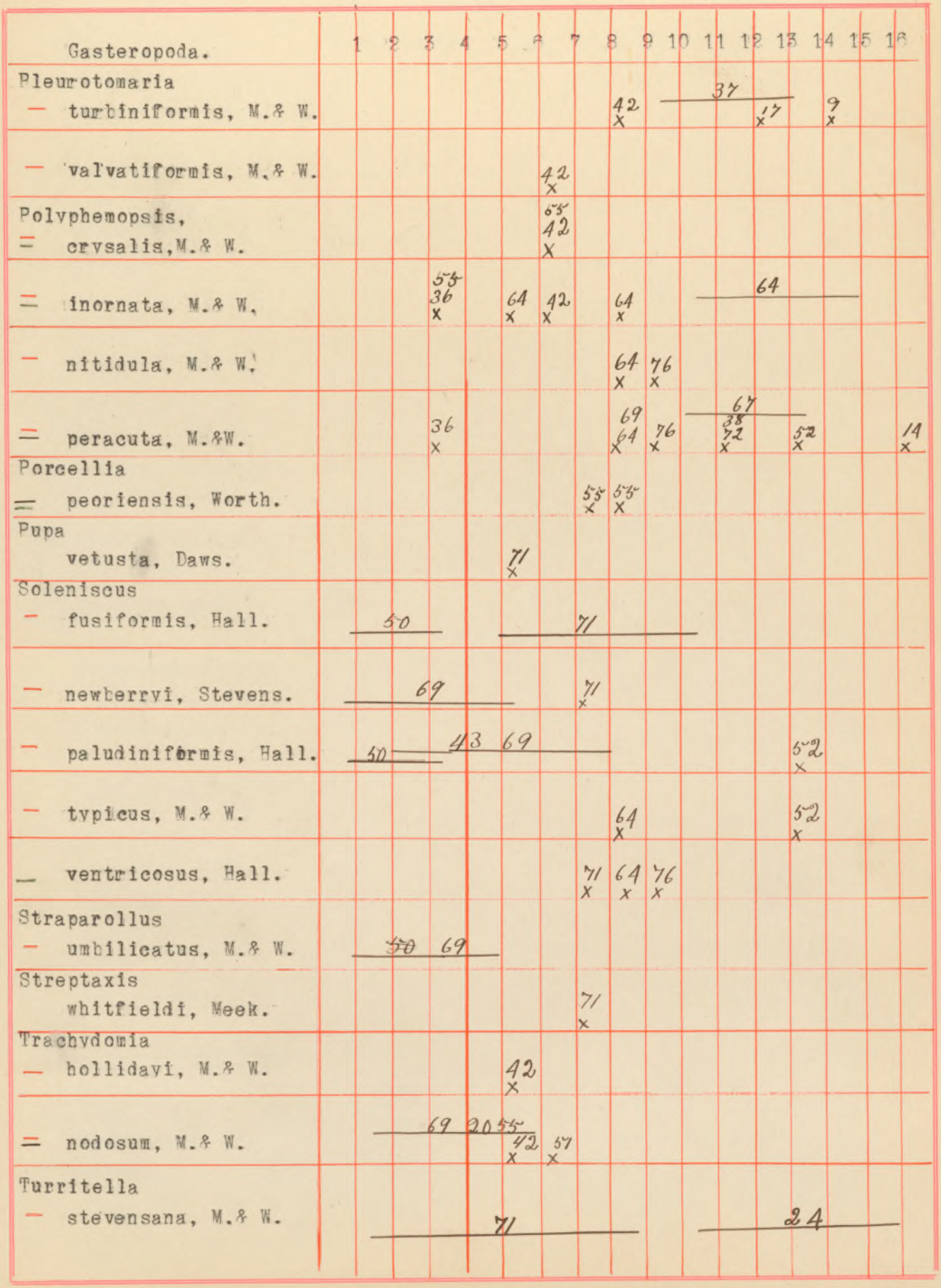
Brachiopoda.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
— Spirifera rockymontana, Marcou.	47	23 50														
Spiriferina = kentuckiensis, Shum.	47	23 73			31		55 71 34		64 42 17	74 37	71	52 2 8	61 10	10 20	9 20	19 12
Streptorhynchus = crassum, M.& H.	47	73	36 53 50 1	23 37	67 49		42 55		71	37 76 2	71	8 2	61	20 52 38	67 32	19 67
Syntrielasma — hemiplicatum, Hall.									79					20 8		
Terebratula = bovidens, Morton.		29 23	5 29	5		42		9 37 71	42 64	76 37 71	27	52 98 9	71	20	32 9	19 14
sacculus, Martin.							71									
Waldheimia — compacta, White &St.			17				71									
Gasteropoda.																
Aclisina robusta, Stevens.							71									
— swallovana, Gein.				57												
Amplexus — zaphrentiformis, White.							71									
Anomphalus — rotulus, M.& W.					42											
Bellerophon = carbonarius, Cox.		24	50 53		9 87 21	64 71	58 64 71	55 64 71	64 71 24	11 71 76	27	72 13 38	61	52 61	32	2 19
= crassus, M.& W.			69	4						76						
= ellipticus, McChes.			50 36		42											
— gigantæus, Worth.			51													
— kansasensis, Shum.			51													

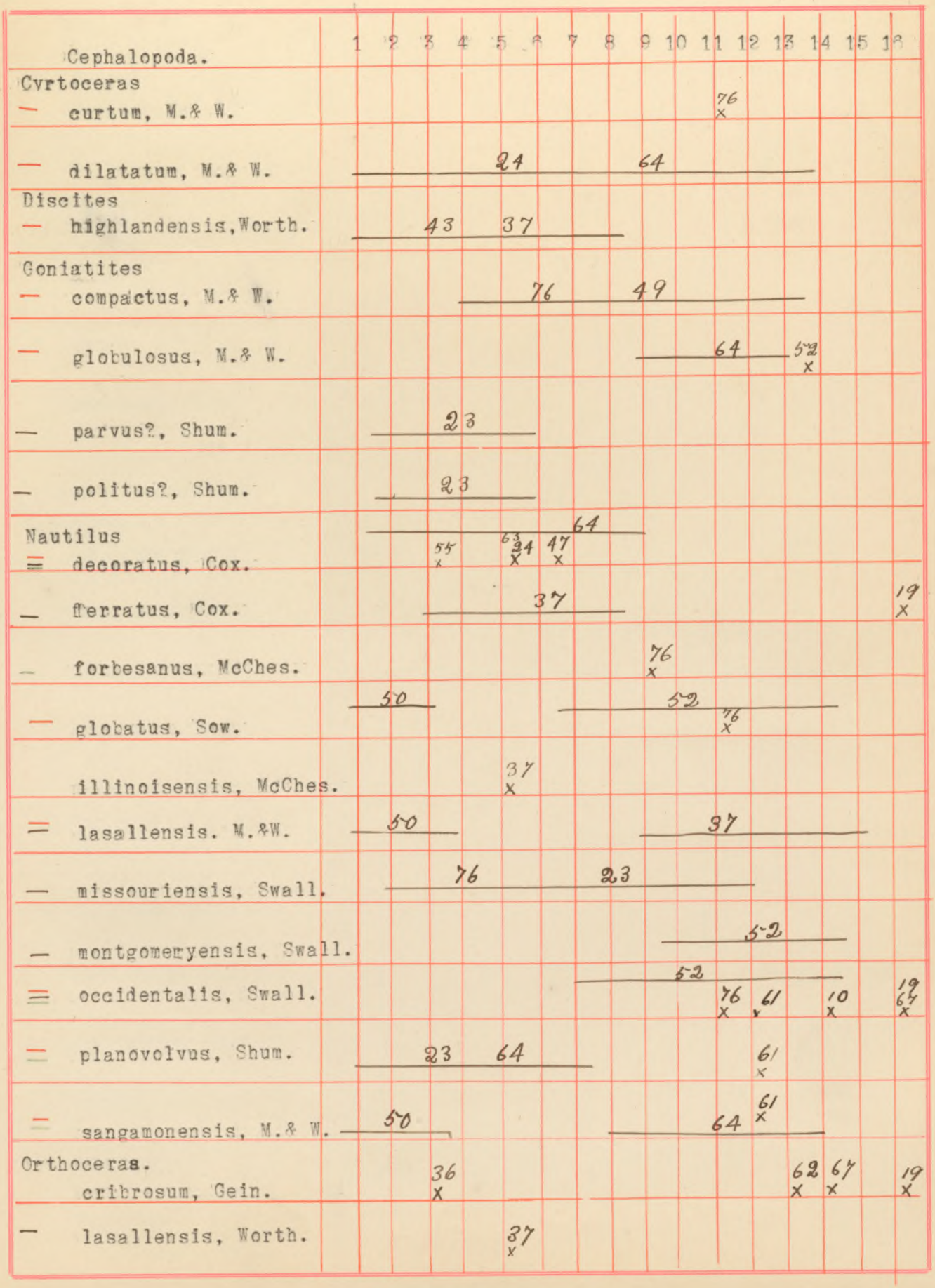
Gasteropoda.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Bellerophon																
= nodocarinatus, Hall.		43	51		81 x	24 x	64 x									
– marcouanus, Gein.			36													
= meekanus, Swall.			47	64	36 x											
– montfortanus, N.& R.		30	73 x	36 30 x	55 x	9	55 71 x	64 24 x	76 x		38 27 x	61 x	61 52 x			19 x
= percarinatus, Conr.		55 50		36 x				24 64 x	11 76 x		98 13 72 x	61 x	52 61 x			14 19 x
– stevensanus, McChes.							64 x	64 x						8 x		
– tricarinatus, Shum.			64	9			75									
Conularia																
– crustula, White.														52 x		
Cyclonema																
percarinatus, Hall.			30 x													
Cyrtolites																
– gillanus, W.& St.J.				49												
Dentalium																
= annulostriatum, M.&W.				64			71 x									
– meekanum, Gein.							71 x									
= sublaeve, Hall.		60					71 *				76 72 x	61 x				
Euomphalus																
– catilloides, Conr.				64												
– pernodosus, M.&W.			43													
– subquadrata, M.& W.														52 x		
= subrugosus, M.& W.		50					55 71 x	64 x	2 76 x		27 76 x	61 x	61 x	61 32 x	67	14 19 x
Ianthinopsis																
tumida, M.&W.											76 x					
Loxonema																
– cerithiforme, M.& W.								64 x								

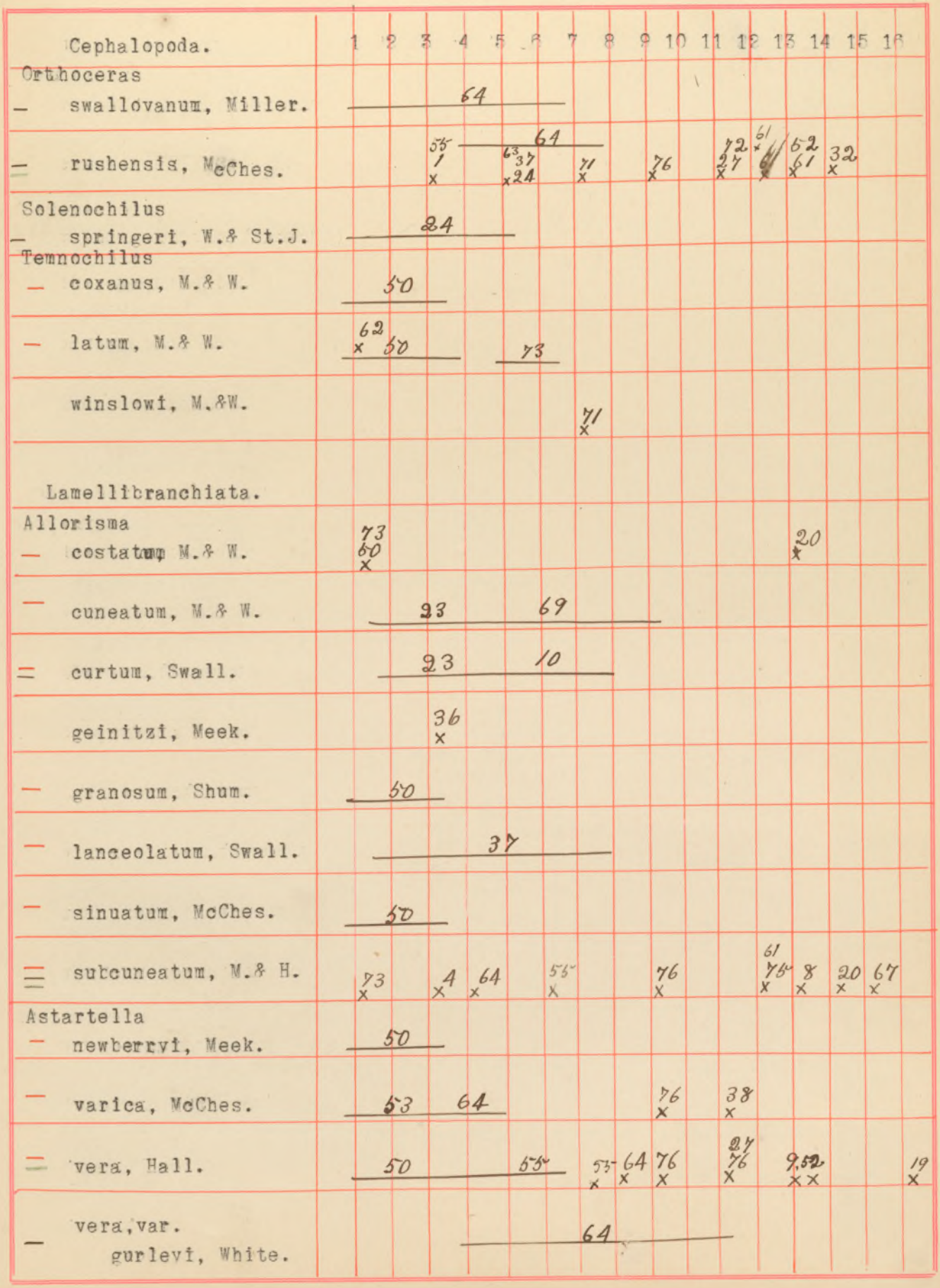
Gasteropoda.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Loxonema																
— minutum, Stev.							71 x									
— millicostatum, M.& W.					42											
— peoriensis, Worth.					55				55 x							
— subcarinatum, Hall.					55				55 x							
— rugosum, M.& W.									64 x							
= scitulum, M.& W.			42													
semicostatum, Meek.									71 x							
Macrochilina																
altonensis, Worth.	43 x															
— intercalaris, M.& W.									64 x				61 x	61 x		
— medialis, M.& W.			36						64 x				61 x	61 x		
ponderosa, Swall.									64 x							
= primogenia, Conr.	23 x		55 36 x		53 x	55 x	55 24 71 x		24 64 x	76 x		38 76 x	75 x	52 x	10 x	14 19 x
Microdoma																
— conica, M.& W.						42 x										
Murchisonia																
— archimedes, McChes.				37												
inornata, M.& W.						42 x										
— lasallensis, Worth.											37					
— terebra, White.					44											
Naticopsis,																
— altonensis, McChes.					42 x											
= gigantea, H.& Whitf.			23		43											
— nana, M.& W.			37			42					64					


Gasteropoda.
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
Naticopsis
pricii, Shum.
76
= subovata, Worth.
37
61
ventricosa, N.& P.
78
42
38
76
= wheeleri, Swall.
43
64
55
55
Orthonema
carbonarium, Worth.
55
55
— conicum, M.& W.
42
— salteri, M.&W.
42
Platyceras
equilaterale, Hall.
66
— nebrascensis, Meek.
76
9
— spinogerum, Worth.
42
42
— tortum, Meek.
37
44
79
— trigonale, Stevens.
42
Platystoma
— gravvillensis, Worth.
76
— peoriensis, McChes.
9
64
55
42
76
37
79
9
12
Pleurotomaria
= adamsi, Worth.
55
55
55
= beckwithana, McChes.
64
55
71
— bonharborensis, Cox.
55
= brazoensis, Shum.
42
64
37
61
= broadheadi, White.
66
37
= carbonaria, N.& P.
24
71
24
38
61
52
10

Gasteropoda.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Pleurotomaria																
= conifformis, Worth.						42 x										
= giffordi, Worth.							55 x	55 x								
— granulostriata, M.& W.						42 x										
= gravvillensis, N.&P.	26,50, 53 73 x		55 36 47 x	37 55 x	24 x	55 68 x	55 71 64 x	64 17 24 x	11 76 x			76 13 38 72 x	61 x	9 61 52 x	32 x	14 19 x
= illinoisensis, Worth.	50 x		55 x				55 x									
— kentuckiensis,	50 73 x		52													
— pratteni, M.& W.						42 x										
— scitula, M.& W.						42 x										
= speciosa, M.&W.						42 x	64 71 x									
= spironema, M.& W.	50					42 x	55 x	49								
— subconstricta, M.&W.			36			42 x		9								
= sphaerulata, Conr.	50	65 x	36 47 x				55 x	17 64 24 x	76 11 x	2 x	61	76 8 72 13 38 x	61 x	9 52 x	67 x	19 14 x
= subscalaris, M.& W.	26					42 x										
— subsinuata, M.& W.						42 x										
= subturbinata, M.&W.				37			55 x									
= tabulata, Conr.									76 x			38 13 72 76 x	61 8 x	61 52 x		
— tenuicincta, M.& W.						42 x						64				

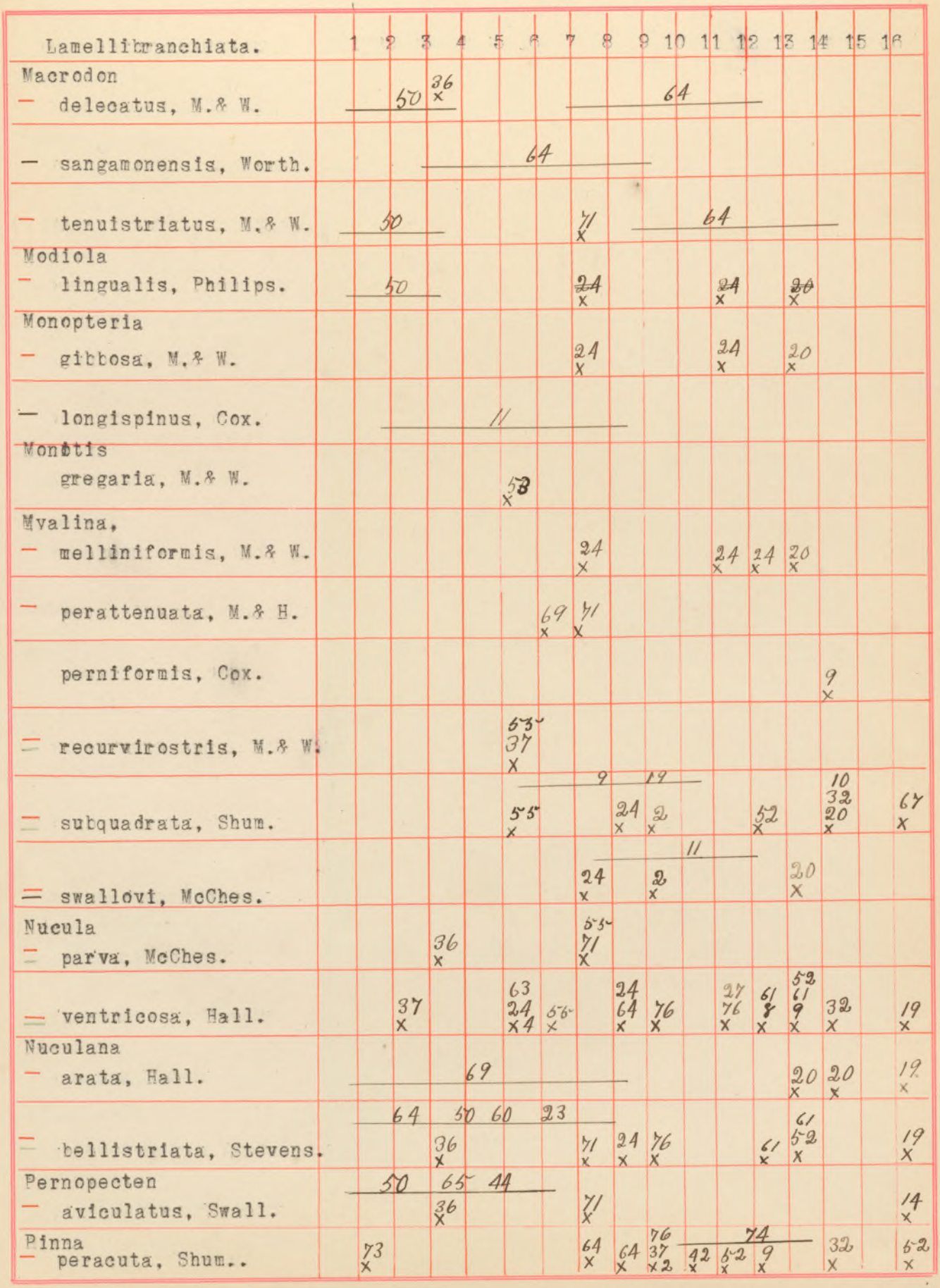

Gasteropoda.
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
Pleurotomaria
— turbiniformis, M.& W.
42 37 17 9
— valvatiformis, M.& W.
42
Polyphemopsis,
= crysalis, M.& W.
55 42
= inornata, M.& W.
55 36 64 42 64 64
— nitidula, M.& W.
64 76
= peracuta, M.&W.
36 69 64 76 67 38 72 52 14
Porcellia
= peoriensis, Worth.
55 55
Pupa
vetusta, Daws.
71
Soleniscus
— fusiformis, Hall.
50 71
— newberryi, Stevens.
69 71
— paludiniformis, Hall.
50 43 69 52
— typicus, M.& W.
64 52
— ventricosus, Hall.
71 64 76
Straparollus
— umbilicatus, M.& W.
50 69
Streptaxis
whitfieldi, Meek.
71
Trachydomia
— hollidayi, M.& W.
42
= nodosum, M.& W.
69 20 55 42 57
Turritella
— stevensana, M.& W.
71 24

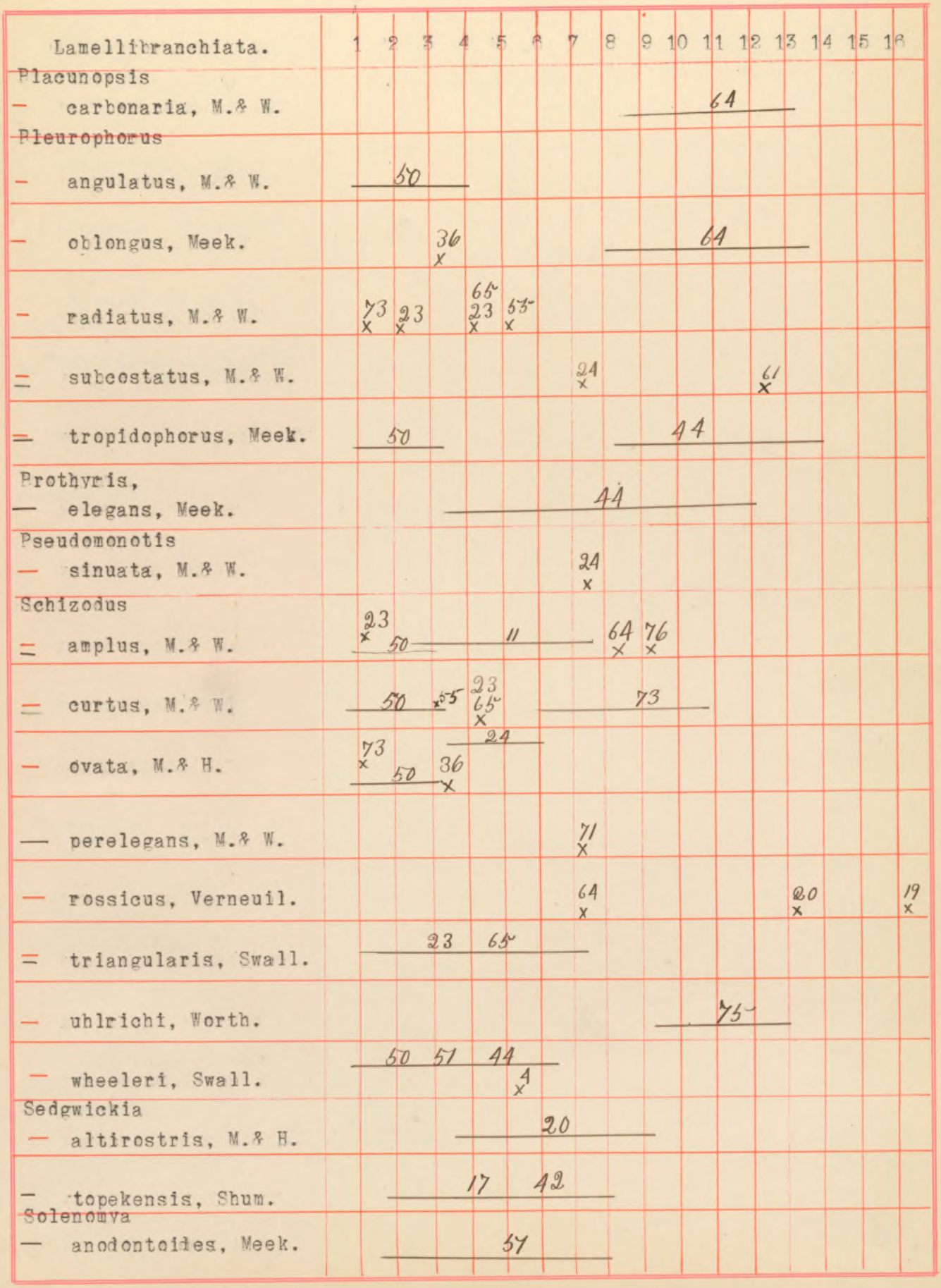

Cephalopoda.
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
Cyrtoceras
— curtum, M.& W.
76
— dilatatum, M.& W.
24
64
Discites
— highlandensis, Worth.
43
37
Goniatites
— compactus, M.& W.
76
49
— globulosus, M.& W.
64
52
— parvus?, Shum.
23
— politus?, Shum.
23
Nautilus
= decoratus, Cox.
64
55
63
34
47
— ferratus, Cox.
37
19
— forbesanus, McChes.
76
— globatus, Sow.
50
52
76
illinoisensis, McChes.
37
= lasallensis. M.&W.
50
37
— missouriensis, Swall.
76
23
— montgomeryensis, Swall.
52
= occidentalis, Swall.
52
76
61
10
19
67
= planovolvus, Shum.
23
64
61
= sangamonensis, M.& W.
50
61
64
Orthoceras.
cribrosum, Gein.
36
62
67
19
— lasallensis, Worth.
37


Cephalopoda.
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
Orthoceras
— swallovanum, Miller.
64
— rushensis, McChes.
55 64
1 43 37
24
71
76
72 61 62
27 61
32
Solenochilus
— springeri, W.& St.J.
24
Temnochilus
— coxanus, M.& W.
50
— latum, M.& W.
62 50
73
winslowi, M.&W.
71
Lamellibranchiata.
Allorisma
— costatum M.& W.
73 50
20
— cuneatum, M.& W.
23 69
= curtum, Swall.
23 10
geinitzi, Meek.
36
— granosum, Shum.
50
— lanceolatum, Swall.
37
— sinuatum, McChes.
50
= subcuneatum, M.& H.
73 4 64 55
76
61 75 8 20 67
Astartella
— newberryi, Meek.
50
— varica, McChes.
53 64
76 38
= vera, Hall.
50 55 53 64 76 27 76 9,52 19
— vera, var.
gurlevi, White.
64

Lamellibranchiata.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Avicula																
— longa, Gein.			36 x		71		71 x									
— morganensis, M.& W.				53												
Aviculopecten																
= carboniferus, Stevens.		50	36 x		64	76						52 x		52 x		14 x
— clevelandicus, Swall.			24													
— coxanus, M.& W.			37 x	37 x												
— interlineatus,												37 x				
= mazonensis, Worth.		x 26 50														
— menardi, Worth.				49												
— occidentalis, Shum.		50	69	48	44		24 x		76 x				63			67 19 x
			36 x						2					20 x		
— pellucidus, M.& W.			36 x	1												
— providencensis, Cox.				64												
= rectilaterarius, Cox.			24	36												
	71 x	65 x	23 53 47 30 x	65 48? x	55 x	37 39 24 x	48? 63 68 x	71 x				27 x				
whitii, Meek.														20 x	20 x	
Aviculopinna																
= americana, Meek.				64									61 x	61 x		
= illinoisensis, Worth.									53 x				61 x	61 x		
Bakevellia																
— illinoisensis, Worth.				37									37			
Carbonarca,																
— gibbosa, M.& W.										37		4		64		
Cardinia																
— fragilis, Cox.				64		68										
				48 x	37 x	48 x	24 x									

Lamellibranchiata.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Cardiomorphia — missouriensis, Shum.	73 50 65 71		65 17 23													
Chaenocardia — ovata, M.& W.		26														
Chaenomya — cooperi, M.& H.			37			38										
— minnehaha, Swall.								11								
Clinopistha, = laevis, M.& W.		23		50	69		55									
= radiata, Hall.		50		23 65	23 64	64	64	64	64	64	64	38	61	61		
Conocardium — obliquum, M.& W.		50				64										
Dolabra alpina, Hall.	23								76							
Crenopecten retiferus, Shum.	62 73		36 56				71									
Cypricardia — occidentalis, Hall.				37												
Edmondia — aspenwalensis, Meek.					64											
— mortonensis, Gein.				23												
— nebrascensis, Gein.		50							20							
— peroblonga, M.& W.									37							
— reflexa, Meek.									37							
= subtruncata, Meek.		50	55		64											
= unioniformis, Philips.							24		24?		61					
Euchondria neglecta, Gein.			64					11								
Macrodon — carbonarius, Cox.			64									72 27				19


Lamellibranchiata.
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
Macrodon
— delecatus, M.& W.
50
36
64
— sangamonensis, Worth.
64
— tenuistriatus, M.& W.
50
71
64
Modiola
— lingualis, Philips.
50
24
24
20
Monopteria
— gibbosa, M.& W.
24
24
20
— longispinus, Cox.
11
Monotis
gregaria, M.& W.
53
Myalina,
— melliniformis, M.& W.
24
24
24
20
— perattenuata, M.& H.
69
71
perniformis, Cox.
9
recurvirostris, M.& W.
53
37
subquadrata, Shum.
9
19
10
32
20
67
55
24
2
52
swallovi, McChes.
11
24
2
20
Nucula
— parva, McChes.
36
53
71
— ventricosa, Hall.
37
63
24
54
56
24
64
76
27
76
61
61
9
52
32
19
Nuculana
— arata, Hall.
69
20
20
19
bellistriata, Stevens.
64
50
60
23
36
71
24
76
61
61
52
19
Pernopecten
— aviculatus, Swall.
50
65
44
36
71
14
Pinna
— peracuta, Shum..
73
64
64
76
37
2
74
42
62
9
32
62

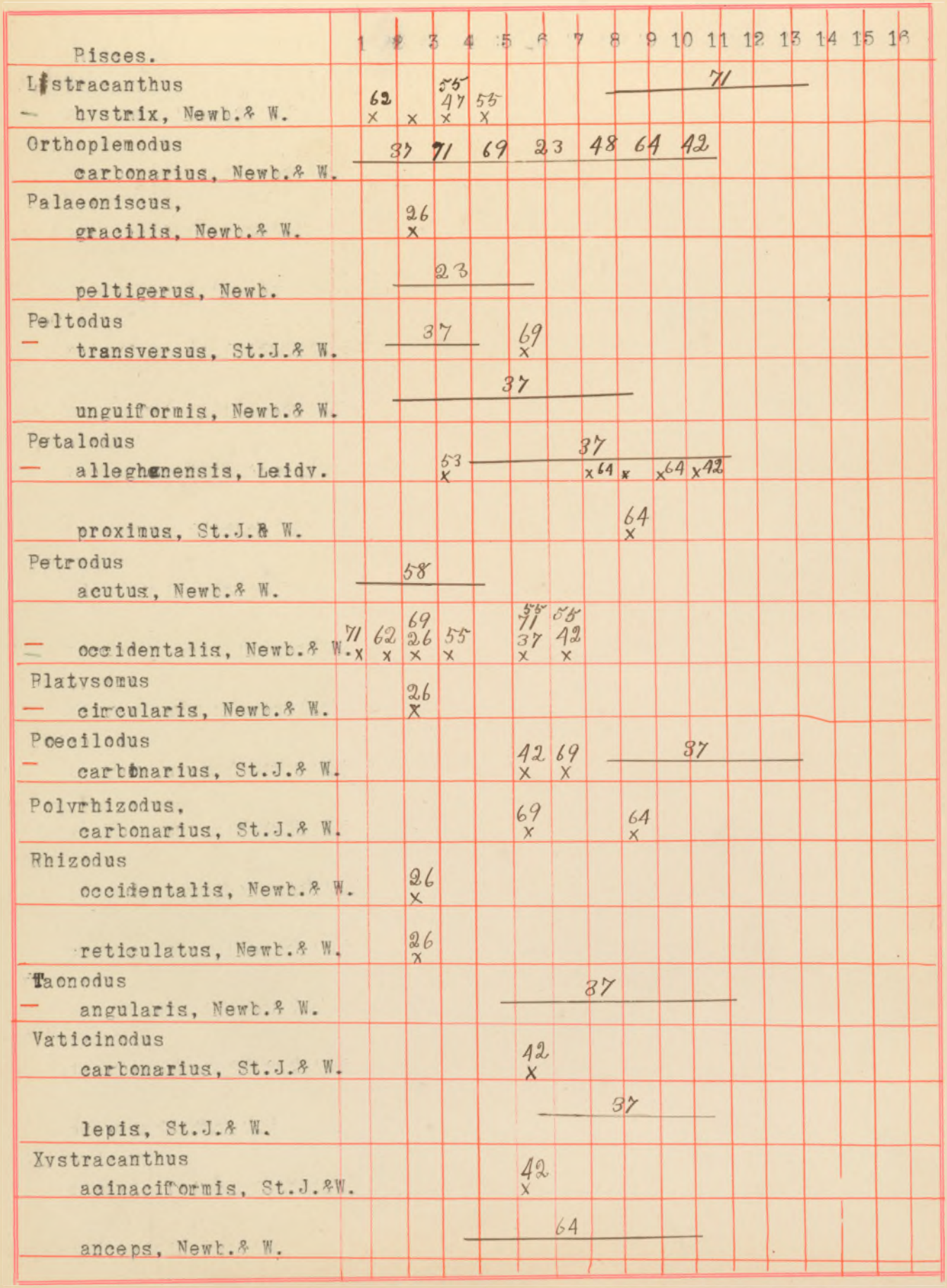

Lamellibranchiata.
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
Placunopsis
— carbonaria, M.& W.
64
Pleurophorus
— angulatus, M.& W.
50
— oblongus, Meek.
36
64
— radiatus, M.& W.
73 23 65 23 53
= subcostatus, M.& W.
24
61
= tropidophorus, Meek.
50
44
Prothyris,
— elegans, Meek.
44
Pseudomonotis
— sinuata, M.& W.
24
Schizodus
= amplus, M.& W.
23 50 11 64 76
= curtus, M.& W.
50 55 23 65 73
— ovata, M.& H.
73 24 50 36
— perelegans, M.& W.
71
— rossicus, Verneuil.
64 20 19
= triangularis, Swall.
23 65
— uhlrichi, Worth.
75
— wheeleri, Swall.
50 51 44 4
Sedgwickia
— altirostris, M.& H.
20
— topekensis, Shum.
17 42
Solenomya
— anodontoides, Meek.
57

Lamellibranchiata.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Solenomya radiata, M.& W.		50 39 55 65 23					71						51 20		20	
Solenomya soleniformis Cox.		65 50 28 24 37									49					
truncata, McWhorter.		50														
Solenopsis solenoides, Gein.			11 44													
Streblopteria tenuilineata, M.& W.	73		65								11	61				
Yoldia carbonaria, Meek.			38									61				
Yoldia knoxensis, McChes.			55 36			36										
Yoldia oweni, McChes.											27		52			
Yoldia rushensis, McChes.			64													
Yoldia subscitula, M.&H.			4													14
Annelida.																
Spirorbis carbonaria, Daws.			47									61	61			
Crustacea.																
Acanthotelson eveni, M.& W.		26														
Acanthotelson stimpsoni, M.& W.		26														
Anthraconectes mazonensis, M.& W.		26														
Anthracopadaemon gracilis, M.& W.		26														
Belinurus lacoei, Pack.		26														

Crustacea.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Ceratiocaris																
— sinuata, M.& W.		26 x														
Chiton																
= carbonarius, Stevens.							71 x		44							
Dipeltis																
diplodiscus, Pack.		26 x														
Dithyrocaris																
carbonaria, M.& W.		26 x				71										
Euproops																
— danae, M.& W.		26 x														
longispinus, Pack.		26 x														
Euripteris																
— mazonensis, M.& w.		26 x														
Leaia																
— tricarinata, M.& W.						71 37 x			11			72 x				69 x
Palaeocaris,																
typus, M.& W.		26 x														
Phillipsia																
— major, Shum.			44													
— sangamonensis, M.& W.							64 x						20 x			
— scitula, M.& W.							55 64 x	42 x								14 x
Arachnida.																
Architarbus																
— rotundatus, Scud.		26 x														
Eoscorpius																
— carbonarius, M.& W.		26 x														
Mazonia																
— woodana, M.& W.		26 x														

Myriapoda.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Acantherpestis — major, M.& W.			26 x													
Amvnilespes wortheni, Scud.			26 x													
Anthracerpes — typus, M.& W.			26 x													
Euphoberia — armigera, M.& W!			26 x													
carri, Scud.			26 x													
— granosa, Scud.			26 x													
horrida, Scud.			26 x													
Palaeocampa anthrax, M.& W.			26 x													
Insecta.																
Chrestotas — lapidea, Scud.			26 x													
Eileticus — anthracinus, Scud.			30													
Ephemerites — affinis, Scud.			26 x													
— gigas, Scud.			26 x													
— simplex, Scud.			26 x													
Gerarus — danae, Scud.			26 x													
Hemeristria occidentalis, Dana.			26 x													
Lithomvlaxris, — simplex, Scud.					71											
Megathentomum — pustulatum, Scud.			26 x													
Miamia — bronsoni, Dana.			26 x													

Insecta.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Mylacris anthracophylum, Scud.		26 x									37 x					
Pisces.																
Acondylacanthus nuperus, St.J.& W.											37 x					
— rectus, St.J.& W.											37 x					
Agassizodus — corrugatus, Newb.& W.	43 x				42 66 x		71 x									
scitulus, St.J.& W.		64 48 26														
variabilis, Newb.& W.									64 37 x							
Amblypteris macropteris, Agas.		26 x			42 x											
Asteroptychius bellulus, St.J.& W.					42 x											
Cholodus inaequalis, St.J.& W.								64 x								
Cladodus carinatus, St.J.& W.					42 x											
fulleri, St.J.& W.			48 x	37												
— mortifer, Newb.& W.				37		69 x					64 x	42 x				
— occidentalis, Leidy.				37								76 x				
pandatus, St.J.& W.											42 x					
Ctenacanthus, buttersi, St.J.& W.					42 x											
Cymatodus oblongus, Newb.& W.										37						
Deltodus propinquus, St.J.& W.					42 x		71 x									
Helodus — carbonarius, Newb.& W.				37 69												
— rugosus, Newb.& W.				43 37												


Pisces.
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
Listracanthus hystrix, Newb.& W.
62 55 47 55 71
Orthoplemodus carbonarius, Newb.& W.
37 71 69 23 48 64 42
Palaeoniscus, gracilis, Newb.& W.
26
peltigerus, Newb.
23
Peltodus transversus, St.J.& W.
37 69
unguiformis, Newb.& W.
37
Petalodus alleghenensis, Leidy.
53 37 64 64 42
proximus, St.J.& W.
64
Petrodus acutus, Newb.& W.
58
occidentalis, Newb.& W.
71 62 69 26 55 55 71 37 55 42
Platysomus circularis, Newb.& W.
26
Poecilodus carbonarius, St.J.& W.
42 69 37
Polyrhizodus, carbonarius, St.J.& W.
69 64
Rhizodus occidentalis, Newb.& W.
26
reticulatus, Newb.& W.
26
Taeonodus angularis, Newb.& W.
37
Vaticinodus carbonarius, St.J.& W.
42
lepis, St.J.& W.
37
Xystracanthus acinaciformis, St.J.&W.
42
anceps, Newb.& W.
64

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Pisces.																
Xystracanthus mirabilis, St.J.& W.					23 x											
Xystrodus bellulus, St.J.& W.							21 x									
Batrachia.																
Amphibamus, grandiceps, Cope.		26 x														